TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

VELI-MATTI USKI

INDUSTRIAL INTERNET OF THINGS -DRIVEN BUSINESS MODEL FOR MANUFACTURING COMPANIES

Master of Science Thesis

Examiner: Professor Samuli Pekkola and Postdoctoral Researcher Jukka Huhtamäki
Examiner and topic approved on 2 May 2018

ABSTRACT

VELI-MATTI USKI: Industrial Internet of Things -driven business model for manufacturing companies
Tampere University of technology
Master of Science Thesis, 77 pages, 2 Appendix pages
September 2018
Master's Degree Programme in Information and Knowledge Management
Major: Information Management and Systems
Examiner: Professor Samuli Pekkola and Postdoctoral Researcher Jukka Huhtamäki

Keywords: Industrial Internet of Things, Business model, Business Model Canvas, B2B, IIoT applications

Currently Industrial Internet of Things (IIoT) is radically changing manufacturing industry. The IIoT connects the physical and digital worlds to a wholeness where physical entities like machines and tools have communication, data processing and sensing capability. The IIoT is changing industry structures and the nature of competition, which has led to a situation where companies must redesign their business models. Without adaptation, most companies can no longer survive. However, many companies are struggling on how they can design business around the IIoT. In fact, one of the biggest challenge the companies are facing while implementing the IIoT is how to build a business case. In other words, for the companies it is challenging to design an applicable IIoT-driven business model.

This thesis studies what are the needs and challenges of the IIoT-driven business models for the manufacturing companies. The goal of the thesis is to understand what kind of business model can support the IIoT software solution business in a manufacturing company. The thesis is conducted in two parts: literature review part and empirical research part. The reason for conducting the literature review is to gain knowledge about the research area and to guide the empirical research. The empirical research investigates a real-life context using multiple sources of data in order to gain rich understanding. The empirical research is conducted using case study approach with semi-structured interviews in the case company. The case company is a large Finnish company which operates globally. The company produces technology, automation and service offerings in the pulp, paper and energy industries.

This research could not reveal fully generalized IIoT-driven business model but characteristics and challenges the company has to take into account while developing IIoT-driven business model and how these affect each other were identified. Also, seven findings were made which describes the IIoT-driven business models. Findings are: 1.) Customer segments affects the implementation of the IIoT. 2.) Existing key resources might enable competitive advantage. 3.) Cost structure, value propositions and customer segment affects the revenue streams. 4.) Customer segments and value propositions affects to the distribution channel. 5.) Value propositions must be attractive enough. 6.) The company must ensure the connection to the customers' data. 7.) Key partners are likely to change. As a conclusion the results indicates that every company must design its own unique IIoT-driven business by taking into account the industry, company's existing business model and peculiarities of the IIoT-driven business models.

TIIVISTELMÄ

VELI-MATTI USKI: Valmistavan teollisuuden teollisen internetin liiketoimintamalli
Tampereen teknillinen yliopisto
Diplomityö, 77 sivua, 2 liitesivua
Syyskuu 2018
Tietojohtamisen diplomi-insinöörin tutkinto-ohjelma
Pääaine: Tietohallinto ja -järjestelmät
Tarkastaja: Professori Samuli Pekkola ja Tutkijatohtori Jukka Huhtamäki

Avainsanat: Teollinen Internet, Liiketoimintamalli, Business Model Canvas, B2B, IIoT sovellus

Teollinen Internet (Industrial Internet of Things, IIoT) on muuttamassa radikaalisti valmistavaa teollisuutta. Teollinen Internet yhdistää fyysisen ja digitaalisen maailman kokonaisuudeksi, jossa fyysiset yksiköt, kuten laitteet ja välineet, pystyvät kommunikoimaan, prosessoimaan dataa sekä havainnoimaan ympäristöään. Teollinen Internet muuttaa sekä toimialan rakennetta, että kilpailun luonnetta, jolloin yritysten on myös muutettava heidän liiketoimintamalliaan. Useat yritykset kuitenkin kamppailevat, siitä kuinka he pystyvät luomaan liiketoimintaa Teollisen Internetin ympärille. Liiketoiminnan rakentaminen on yksi yritysten suurimmista haasteista, Teollista Internetiä rakennettaessa.

Diplomityössä tutkitaan Teollisen Internetin liiketoimintamallien tarpeita ja haasteita valmistavalle yritykselle. Diplomityön tavoitteena on ymmärtää, minkälainen liiketoimintamalli tukee valmistavan teollisuuden yrityksen Teollisen Internetin ratkaisuja. Tutkimus on toteutettu kahdessa osassa: kirjallisuuskatsaus ja empiirinen tutkimus. Kirjallisuuskatsauksen tavoitteena on kerätä tietoa tutkittavasta aiheesta, sekä ohjata empiiristä tutkimusta. Empiirisellä tutkimuksella pyritään hankkimaan arvokasta tietoa reaalimaailman kontekstista useita tietolähteitä käyttäen. Empiirinen tutkimus on toteutettu tapaustutkimuksena kohde yrityksessä hyödyntäen puolistrukturoituja haastatteluja. Kohdeyritys on suuri, kansainvälisesti toimiva suomalainen yritys, joka tuottaa teknologia-, automaatio- ja palvelutuotteita, sellu-, paperi- ja energiateollisuuden toimialoille.

Tutkimus ei pystynyt tuottamaan täysin geneeristä Teollisen Internetin liiketoimintamallia. Tutkimuksen avulla pystyttiin kuitenkin paljastamaan ominaispiirteet ja haasteet, jotka yrityksen täytyy ottaa huomioon liiketoimintamallia suunniteltaessa sekä kuinka nämä vaikuttavat toisiinsa. Lisäksi tutkimus tuotti seitsemän löydöstä, jotka kuvaavat Teollisen Internetin liiketoimintamalleja. Löydökset ovat: 1.) Asiakassegmentit vaikuttavat Teollisen Internetin implementointiin. 2.) Yrityksen olemassa olevat resurssit saattavat tarjota kilpailuetua. 3.) Kulurakenne, arvolupaus ja asiakassegmentit vaikuttavat ansaintamallin valintaan. 4.) Asiakassegmentit ja arvolupaus vaikuttavat jakelukanavan valintaan. 5.) Arvolupauksen on oltava riittävät houkutteleva. 6.) Yrityksen on varmistettava pääsy asiakkaan dataan. 7.) Kumppanit todennäköisesti muuttuvat. Tulokset viittaavat siihen, että jokaisen yrityksen täytyy suunnitella oma uniikki Teollisen Internetin liiketoimintamalli huomioimalla toimiala, yrityksen nykyinen liiketoimintamalli, sekä Teollisen Internetin liiketoimintamallien erityispiirteet.

PREFACE

In 2014, I started studying Information and Knowledge Management in Tampere University of Technology without even knowing what I was going to study. Now four years later I find myself writing thesis of Industrial Internet of Things and Business models. Subjects that I had not even heard before I started my studies in the university. During my studies, I have learned many interesting things but more importantly, I have met amazing people.

Year ago, I was granted an opportunity to conduct a thesis in a case company. I started the project on February and the last spring has been intensive but instructive as well. It has been a great opportunity to work with real-life problem while learning new things. I am grateful for this opportunity and the resources the case company has been invested in this project. I would like to express my gratitude to my superior, my colleagues and the company in general.

Additionally, I would like to thank my supervisor professor Samuli Pekkola at Tampere University of Technology for his guidance and advices. Furthermore, I would like to thank postdoctoral researcher Jukka Huhtamäki for his advices.

Finally, I would like to express my gratitude to my family, friends and especially my lovely girlfriend Sini who have been supported me along this thesis and studies in the university. These people have make it possible.

"Education is the most powerful weapon which you can use to change the world."

-Nelson Mandela

Tampere, 6.9.2018

Veli-Matti Uski

CONTENTS

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

B2B	Business to Business
B2B2C	Business to Business to Customer
DevOps	Development and Operations
ICT	Information and Communication Technology
IIoT	Industrial Internet of Things
IoT	Internet of Things
IPR	Intellectual Property Right
IT	Information Technology
MVP	Minimum Viable Product
R&D	Research and development

1. INTRODUCTION

In this chapter, the background and motivation of the research are introduced first. The chapter sheds lights on why is this thesis conducted and what is the context of the research. Next the research problem, research questions and objectives are introduced. The main and the sub-questions are addressed and the criteria behind on why they were chosen is clarified. After that the research limitations and scope are introduced. Finally, the research structure is introduced.

1.1 Research background and motivation

According to Song et al. (2017) one of the most significant inventor, engineer and physicists Nikola Tesla predicted the mobile phone and the networked world almost a hundred years ago:

> *"When wireless is perfectly applied, the whole earth will be converted into a huge brain, which in fact it is, all things being particles of a real and rhythmic whole. (Nikola Tesla, 1926)"*

All things are particles of a wholeness which form a huge brain is almost like a definition of the Internet of Things (IoT). The IoT has been declared one of the most hyped technologies in 2015. The IoT can be defined as an extension of the classical internet. The classical internet is limited to exchanging data and documents while IoT is connecting to everyday objects. (Song et al. 2017) However, according to Porter & Heppelmann (2014) the fundamental difference of IoT is not the internet but the changing nature of things. It expands capabilities of products and data, which leads in a new era of competition.

In the era of the IoT many companies are struggling with the question of how they can benefit from the digitalization. Industrial Internet of Things (IIoT) is a typically used term of the IoT in an industrial environment (Song et al. 2017). According to Porter & Heppelmann (2014) the IIoT is changing industry structures and the nature of competition. This has led to a situation where companies must change their value proposition, value capturing mechanism, value network and value communication. Without adaptation, most companies can no longer survive.

To survive, companies must redesign their business models. In the recent years, IIoT-driven business models have been studied increasingly. For example, Google Scholar gives 355 results after year 2015, 56 results in between 2012-2015 and only 8 results before the year 2012. These studies are viewing the IIoT from several perspectives. Many studies are focusing on the potential and challenges of the IIoT. However, there are only few studies which focus on implementing the business model on a case company. The studies are also divided according to the focus of the IIoT. The business models are different depending on e.g. if the company utilizes the IIoT in their own production, if the company is selling IIoT hardware or if the company is selling IIoT overall solutions. Many studies focus on the situation where a company is utilizing the IIoT on its own production and how that is changing the business models. Many studies also do not make

a distinction between the kinds of IoT solutions in question. For example, the business model for a monitoring solution might be quite different than that for an autonomous solution.

This research gains insight of possibilities and problems creating value around IIoT solutions in business-to-business (B2B) manufacturing companies which sell large personalized systems. The research answers to an actual problem of the case company. The case company is struggling with the question how can they create value for customers using their IIoT software solutions and how can they turn it to a profitable business. The research provides knowledge for the companies which are designing IIoT-driven business model.

1.2 Research problem, research questions and objectives

This research investigates the expansion of a manufacturing company's system offerings to software solutions. The research studies IIoT-driven business models and provides tools for determining appropriate business model for a manufacturing company. To achieve this, the following research question are set:

- *What kind of business model can support the IIoT software solutions business in a manufacturing company*?

To answer this question, the subject related to the context need to be defined. First, both the IIoT and Business model need to be defined and how the IIoT affects business models. Moreover, we need to understand the business environment of the case company and what challenges it causes. To resolve these, the following sub-questions are addressed:

- *Which business model characteristics are appropriate for a manufacturing company's IIoT software solutions?*
- *What challenges does the business environment causes for implementing such a business model?*

All the research questions are answered through the literature review and empirical research. The empirical research gains more insight on how the sub-questions are linked to the main research question. The main goal of the empirical research is to answer the questions that the literature review leaves unanswered. Finally, the main research question is answered in the discussion chapter.

1.3 Research limitations and scope

This research is a case study of changes in a one company's business. Thus, the business environment of the company defines largely the scope of the study. The company operates globally and it has customers all around the world. The company is classified as a large enterprise. The subject is limited to B2B manufacturing companies which have only few large customers. It has a great impact on a business model if a company has a small number of customers with a large purchasing power instead of the other way around. Company's product portfolio is wide, but the company mostly sells large systems with service agreements.

The research focuses on the IIoT systems in the customer's premises that the company maintains. The research focuses mainly on the platform and enterprise layers of the IIoT's architecture from implementation viewpoint. In other words, the thesis studies IIoT software solutions and the logic behind the software solutions in the platform but excludes the edge layer such as sensors, actuators and communication channels. However, this layer cannot be ignored entirely.

There are limitations in the sampling as well, because all the interviewees are employed within the organization. Customers or partners have not been interviewed. However, the interviewed people had different backgrounds and they worked in different roles. Some of them worked in different business lines. Thus, they had different opinions about the IIoT but the vision was mainly uniform. The interviews were conducted in Finland and Sweden, but all the interviewees worked globally which gives realistic image of the business environment. The number of the interviewees was 13 but it covered management of the Industrial Internet business line well.

1.4 Research structure

This thesis consists of theoretical part and empirical research. The introduction chapter includes the research background and motivation, research problem, research questions and objectives, research limitations and scope and research structure. Second chapter describes the research methodology of the thesis. The literature review methodology and how it is conducted is introduced first. After that the empirical research methodology and how the quality of the research is ensured are introduced. Moreover, the chapter describes which data sources are used and how. Finally, the background of the case company is introduced. Third, fourth and fifth chapter contain the literature review part and theoretical background of the thesis. Chapter three view the Industrial Internet of Things concept and its benefits and challenges. Chapter four introduces the concept of a business model and how it is used. In addition, the Business Model Canvas is explained. Fifth chapter studies business models of the Industrial Internet of Things presented in literature.

Chapter six introduces how the empirical research is conducted and the guiding questions of the interviews and the interviewees are presented. The results of the empirical research are presented in the sixth chapter as well. The results of the thesis are presented at chapter seven. In this chapter, the answer for the research question is presented. Finally, in eight chapter the thesis is summarized and critically analyzed. Furthermore, the future research directions are proposed.

2. RESEARCH METHODOLOGY

In this chapter, the research methodologies of the research and background of the case company are introduced. The thesis is conducted by using a literature review and an empirical research. A case study is chosen as a research methodology of the empirical research. This chapter sheds light on why these methodological approaches are chosen and how those will be conducted.

Saunders et al. (2009) argues that there are two approaches to how a researcher can relate to theory. In the deductive approach researcher first creates a hypothesis based on theory and then tests it by conducting the research. Finally, the theory is modified based on the findings. In the inductive approach, the theory is formulated by analyzing results of the research. The inductive approach is better suited when the purpose of the research is better understanding of the problem's nature. The inductive approach is also suitable if there is little literature on the subject.

Deductive approach is chosen to this research because there isn't clear picture of the desirable business model in the company. The hypothesis helps to guide the discussion on right direction. The research is conducted on six phases:

1. Conducting literature review.
2. Creating initial business model based on theory.
3. Interviewing personnel about the case company's current business processes and strategy using initial business model to guide the study.
4. Triangulating the data using supporting data sources.
5. Studying differences between initial business model and literature
6. Drawing conclusions and formalizing the final business model and modifying the theory.

2.1 Literature review

The literature review can be conducted for two reasons. First reason is to help generating research idea. The other reason is to gain knowledge about the research area and helps the researcher to form big picture of the topic. (Saunders et al. 2009) In this research the reason for conducting the literature review is to gain knowledge about the research area. Purpose of the literature review is to guide the empirical research. The nature of this research does not require systematic literature. The literature review is conducted on six steps presented in Figure 1.

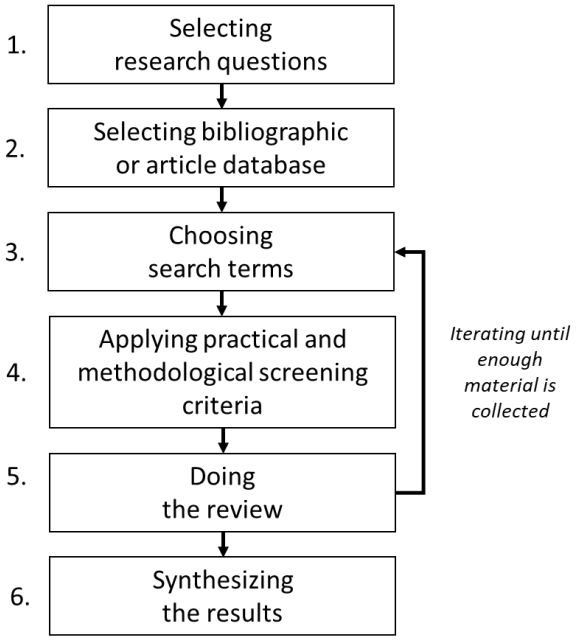

Figure 1 Literature review process.

Scopus, Google Scholar and ScienceDirect are chosen as a bibliographic database of the research. Article search is conducted by using AND, OR and NOT Boolean operations. In the Table 1 is presented chosen search terms.

Table 1 Search terms

Search terms
"IIoT" AND "Business models"
"IIoT" AND "Manufacturing business"
"IIoT" AND "Revenue model"
"Industrial Internet of Things" OR “Industrial IoT” AND “Business model”
“Digital offering” AND "B2B" AND "Manufacturing industry"

To keep the material relevant practical and methodological screening criteria are defined. Applying practical screening criteria includes choosing for example language and publication date of the articles. Applying methodological screening criteria means choosing the type of literary material such as literature review or book. (Fink 2013) Applying practical and methodological screening criteria are both presented in Table 2.

Table 2 Applying practical screening criteria.

Include criteria

Written in English or Finnish Published in 2012 or after Open access Paper type: • Literature review • Empirical research • Book • Review • Conference paper • Journal articles Field of Science: • Business, Management and Accounting, • Economics, Econometrics and Finance, • Engineering
Delimit criteria
Technical information security Paper type: • Patents • News Field of Science: • Human resource, • Computer Science

The topic of the research is fairly new, but it is still quite widely studied. Thus, the literary material is limited to concern only papers which are published after 2012. In the sixth step, the literary will be limited through title and abstract. The literary review will be carried on until enough material has been found. Finally, chosen literary material will be evaluated critically.

2.2 Empirical research

According to Saunders et al. (2009) a case study is a research strategy which involves an empirical investigation in a real-life context using multiple sources of evidence. The case study investigates a contemporary phenomenon which is hard to distinguish from the context (Yin 2009). The case study strategy is suitable if the goal is to gain rich understanding of the context and processes. The case study answers the questions 'why' and 'how'.(Saunders et al. 2009 pp.145-147.; Yin 2009 pp.8-9.) Due to the nature of the research question and context of the research, the case study strategy is chosen for an empirical research method of this thesis.

The case study may use various data collection techniques, like interviews, observation, documentary, analysis and questionnaires. The data sources can be triangulate, which means that different data sources support one another and ensure reliability of the results.

(Saunders et al. 2009 pp. 145-147.) In this research, the main source of data will be interviews. Documentations and observation in the meetings will be used as a supporting data sources to ensure the triangulation of data.

2.2.1 Interviews

The research is conducted using semi-structured one-to-one interviews. In a semi-structured interview, the interviewer has a list of themes and questions which he/she want to cover. The list can vary in different interviews. The flow of the conversation determines the course of the interview. Strength of the semi-structured interview is that it let interviewees explain and build responses (Saunders et al. 2009 pp. 320-324.) In this research, it is essential that the interviewees can explain in their own words and the questions only guide to right direction. Interviews can be conducted either one-to-one basis or in groups. One-to-one basis interviews can be conducted e.g. face-to-face, through telephone or the Internet. (Saunders et al. 2009 p.321) One-to-one interview method is chosen due to fact that finding a common time among the interviewees is difficult. Moreover, in one-to-one interview the opinions of other interviewees will not affect the outcome (Saunders et al. 2009 p.345).

The interviewees are chosen using snowball sampling. In snowball sampling, first is chosen one or two members of case population and after the interview ask them to identify further possible interviews and so on. Snowball sampling is widely used when it is hard to identify possible targets. (Saunders et al. 2009 pp. 240-241.) The reason for choosing the snowball sampling technique is that it is easy to identify few targets but after that it gets hard.

2.2.2 Secondary data sources

Documentation and observation in the meetings were used as a secondary data sources for triangulation of the data. According to Saunders et al. (2009 pp. 258-259.) documentation can be for example, notices, emails, reports to stakeholders, transcripts of speeches, magazine articles or newspapers. Documentary data also includes non-written materials such as voice, video, pictures and drawings. Documentation can be used to reveal reasons behind managers' decisions. Documentation used for data source are:

- Project's target / motivation documentation,
- Estimated business potential documentation,
- Resources and cost defined documentation,
- Technical Design documentation,
- Use case descriptions,
- Company's strategy and vision documentation,
- Annual reviews.

These documents were used to confirm managers' opinions and decisions. The documents were chosen because they reveal facts behind decisions and collects details of the solutions. While using documents one should notice that the documents are done for specific audience and time and that they might have changed already.

2.2.3 Quality of the research

There are a lot of criticism towards the quality of case studies. Quality factors of a research are construct validity, internal validity, external validity and reliability. The criticism of the construct validity in case study focuses on insufficient operational measures set. The criticism state that the researcher's subjective judgements influences the data collection. However, the construct validity can be ensured by using multiple sources of data and establishing a chain of evidence. (Yin 2009 pp. 40-42.) In this research, the construct validity is ensured by using multiple data sources and a chain of evidence will be done as comprehensively as possible.

The criticism toward the internal validity of the case study state that researcher's conclusions of causal relationships are not valid. This criticism has been targeted on explanatory studies and the validity can be ensure using pattern matching. The broader criticism focuses on subjectivity of the researcher conclusions. In this case, the validity can be ensured by addressing rival explanations. (Yin 2009 pp. 42-43.) This research is not explanatory and thus pattern matching doesn't have to use. Furthermore, subjectivity of the researcher is minimized by presenting rival explanations.

External validity of the case study is criticized by the generalizability of the findings. Critics argue that the findings are not generalizable because the context of the study is unique. However, a case study relies on analytic generalization instead of statistical generalization. In analytic generalization, the broader theory is led from a set of results and results are generalizable in specific context. The study can be confirmed by repeating the test in similar context. (Yin 2009 pp. 43-44.) The external validity is ensured by reflecting the study to the theory.

Reliability of the study require that the results are the same if the test is repeated. In the past, many case studies failed to make it possible to repeat the research because lack of documentation. Thus, reliability of the study can be ensured by documenting procedures. Rule of thumb is that the auditor can repeat every procedure and arrive the same results. (Yin 2009 p. 45.) Reliability of the study is ensured by documenting every procedure of the research.

2.3 Case company description

The case company is a large Finnish joint-stock company which operates globally in over 30 countries. The company produce technology, automation and service offerings to its customers. Technology offerings are integrated systems which consist of several individual machines. Automation offerings range from individual measurements to whole factory automation. Service offerings are performance and reliability improvement services and factory maintenance services. The company's customers operate in the pulp, paper and energy industries. The number of customers in the market is small but individual customers are large companies with high purchasing power.

Recently, the company has started to create IIoT offerings to its current customer segments. The company's IIoT solution offerings are divided into two groups: reliability and performance solutions. The goal of the IIoT solutions is to improve customer's performance and profitability. The IIoT solutions are integrated to company's current offerings

and the value is created from the data created by the company's other offerings. Company's Industrial Internet positions in the middle of the offering triangle which is illustrated in Figure 2.

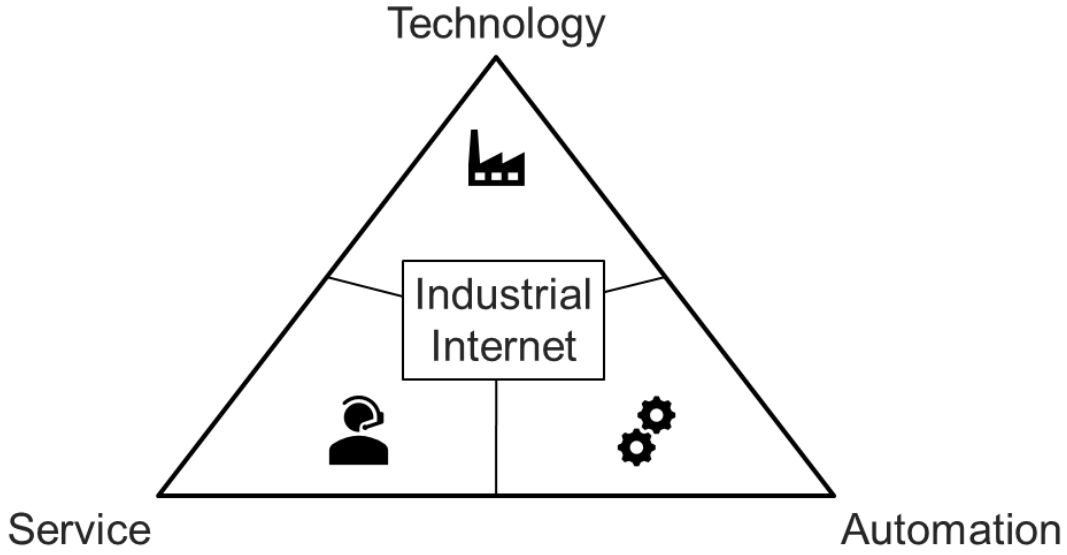

Figure 2 Case company's business lines.

However, the company's IIoT business so far rather unorganized and the company don't have clear business model for its IIoT solutions. The company has created several IIoT solutions but there is not a uniform way to create and sell them. The company has a clear vision and it has done several strategic decisions. Still the business model and the process layers remain underdeveloped

3. INDUSTRIAL INTERNET OF THINGS

Digitalization seems to be one of today's hottest trends. Digitalization is radically changing manufacturing companies. Companies are trying to create added value for their customers and optimizing their own and partners processes through digital solutions. An Industrial Internet of Things is a way to digitalize company's operations. (Gierej 2017)

This chapter explains the Industrial Internet of Things. The term Industrial Internet of Things is first introduced through different definitions and perspectives. In the next subchapter, the IIoT is introduced through its architecture. In the following subchapter are presented IIoT offerings and IIoT companies roles. Then is presented the benefits of implementing the IIoT. Finally, the challenges the business environment causes are discussed.

3.1 The definition of an Industrial Internet of Things

Industry 4.0, Industrie 4.0 or fourth industrial revolution is a term which reflects this current transition in the industry. Industry 4.0 originates from German where several public and private institutions decided to create a reference model for modern industry around 2010 (Montanus 2016; Huxtable & Schaefer 2016). According to Song et al. (2017) the term Industry 4.0 was introduced in 2011 at the Hannover Fair in Germany. Industry 4.0 is quite hard to define due to width of concept. Industry 4.0 contains:

- The Internet of Things (IoT),
- The Internet of Services,
- Smart Factories,
- Cyber Physical Systems,
- Big Data,
- Cloud Computing,
- Cyber Security,
- Autonomy.

Industry 4.0 is a widely adopted concept in Europe. The Industrial Internet is a corresponding term in the America. (Huxtable & Schaefer 2016) However, Thoben et al. (2017) argues that the corresponding term in the America is smart manufacturing.

There is not a clear opinion in the literature that if the Industry 4.0 and the Industrial Internet of Things (IIoT) imply the same thing or not. According to Kiel et al (2017a) the IIoT is a narrower term for digitalization of manufacturing companies. Industry 4.0 or its other name, the fourth industrial revolution, is the transformation which manufacturing industry is currently undergoing. The IIoT is a more practical approach to this fourth revolution. The IIoT is a way for an industrial factory to bundle the physical world, the virtual world and industrial processes together. (Arnold et al. 2017a) The IIoT is more ICT oriented term than Industry 4.0 (Thoben et al. 2017). Gilchrist (2016) mixes up the term Industrial Internet and Industrial Internet of Things in his text but admits that the Industry 4.0 is more conceptual and strategical term than Industrial Internet of Things (IIoT).

This research uses the IIoT term and considers it as a practical implementation of the Industry 4.0 components. According to Arnold et al. (2017b) the IIoT is development of a real-time value chain connection for product or system. For this, Kiel et al. (2017) add that the IIoT is a complex system which connects people, machines, objects and information both vertically and horizontally with real-time capabilities. In turn, Gilchrist (2016) describes the IIoT as a wholeness of key technologies which make a system more than sum of its components. IIoT consist of the same things which were listed as belonging to Industry 4.0. Similarly, Thoben et al. (2017) describes the IIoT as a way to connect industrial assets together. In IIoT the physical entities like machines and tools have communication, data processing and sensing capability. Finally, Arnold et al. (2017b) remark that the software service development is a crucial part of the IIoT.

3.2 Industrial Internet of Things architecture

Industrial Internet of Thing can be examined through IIoT architecture. There are several ways to present IIoT architecture. The functional viewpoint is one way to study the IIoT architecture. In the functional viewpoint, the architecture is divided into five functional domains: control, operations, information, application and business domain.

The control domain is a representation of tasks such as reading the data from sensors and controlling the machine. The operation domain is a representation of tasks such monitoring, prognosis, and optimization. The operation domain collects the data from control level in a one place and processes the raw data. The information domain represents the processing of data to information and knowledge. Processed information can be used in the business decision-making process. The application domain is a representation of the user interface and functions. The business domain represents the integration between IIoT system and the enterprise business systems. For example, the IIoT system can automatically create an order of a spare part when it notices that the part should be change. (Gilchrist 2016 pp. 68-75.) Functional domains are presented in Figure 3.

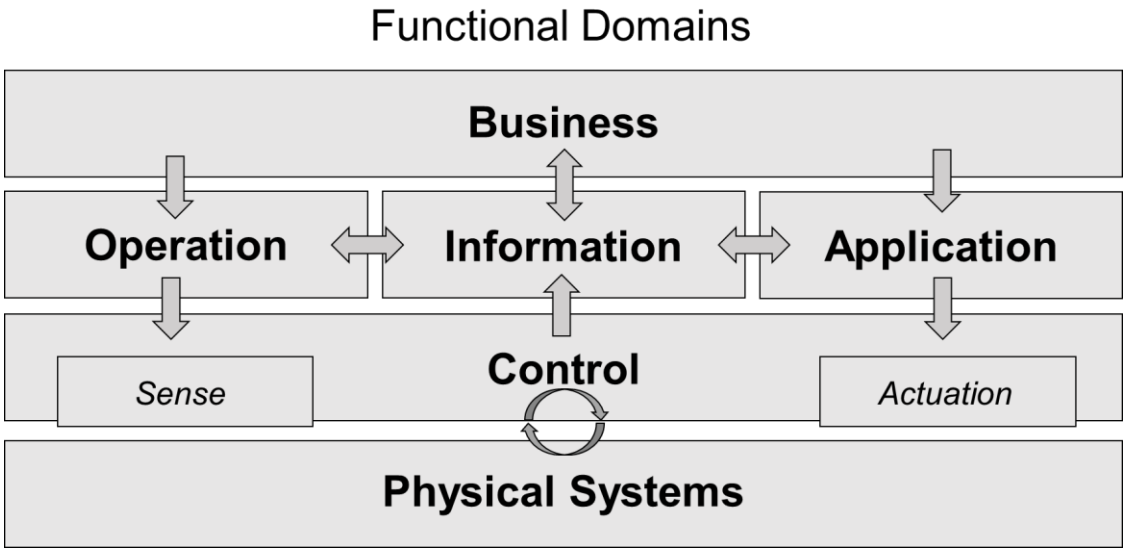

Figure 3 Functional Domains adapted from (Gilchrist 2016 p. 69.).

Implementation viewpoint is another way to study the IIoT architecture and it views architecture from technological angle. The Three-Tier Topology is a simplistic visualization of the IIoT system core areas. The Three-Tier Topology consists of three tiers: the edge tier, the platform tier and the enterprise tier. The edge tier collects all the data from end nodes and controls them. The platform tier processes and analyzes the data that it receives from edge tier. The enterprise tier, that acts as an interface for the end-user, includes the business logic. (Gilchrist 2016 pp. 75-77.) The Three-Tier Topology is shown in Figure 4.

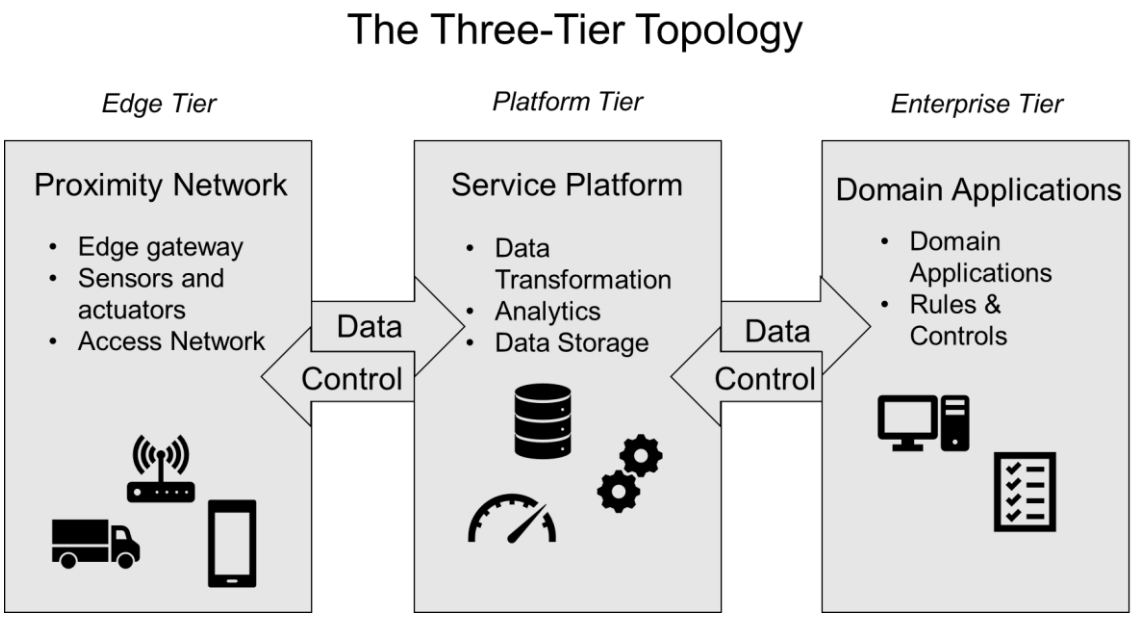

Figure 4 The Three-Tier Topology adapted from (Gilchrist 2016 p. 77.).

In the Three-Tier Topology the data flow is from the edge tier towards the enterprise tier and control flow is in the opposite direction. However, the functional and implementational architectures are not separate entities but they can be illustrated in one picture. The relation between the functional and implementational architecture is presented in Figure 5.

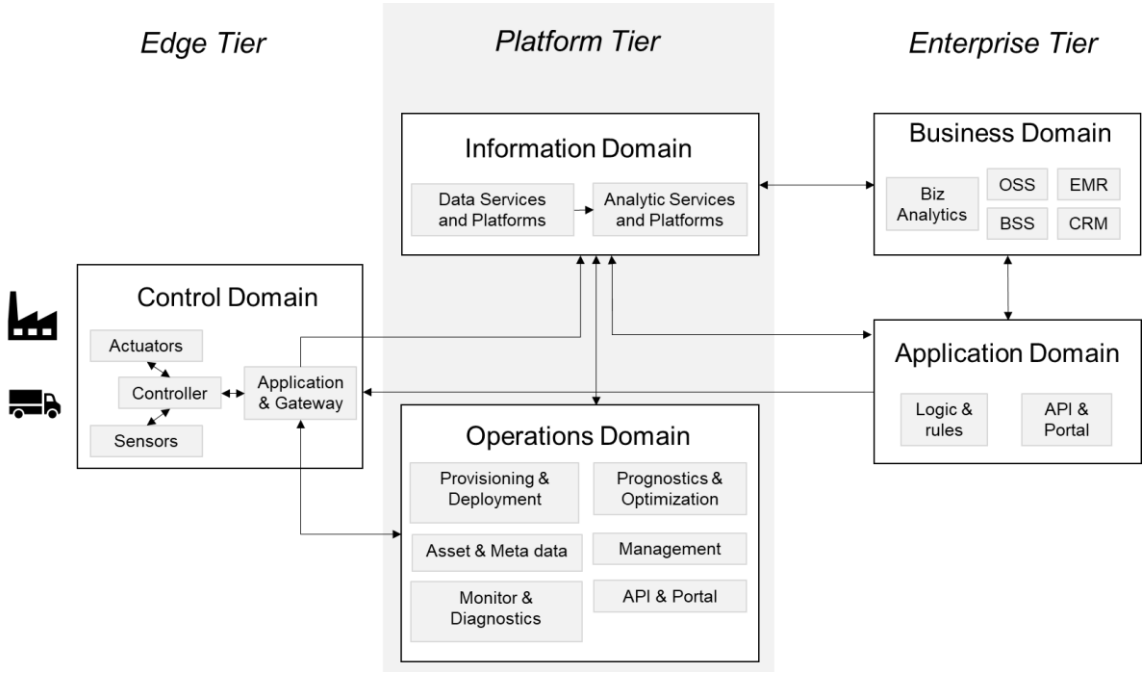

Figure 5 The relation between the functional and implementational architecture adapted from (Usländer & Batz 2016).

This presentation explains the IIoT entity quite well. The control domain is in the edge tier and it communicates with the physical world. In the platform tier the data from the control domain is processed. The end-user does not communicate with this tier in any way. Finally, there is enterprise tier which operates as an interface between the end-user and the IIoT system.

3.3 Industrial Internet of Things capability levels

IoT-based offerings are either revisions of a current offering or extensions by a newly developed offering. Revision strategy can either replace the current offering with more advanced offering or modify the current offering by reducing complexity or increasing customization. Extension strategy can either increase vertical integration in company's value chain or create new offerings unrelated to the current market segment. (Gerpott & May 2016)

Porter & Heppelmann (2014) divides IIoT offerings into four capability levels: Monitoring, Control, Optimization and Autonomy offerings. As can be seen in Figure 6, capabilities are stacked in a way that higher-level capability also includes the lower-level capabilities. For example, optimization requires monitoring and control level capabilities.

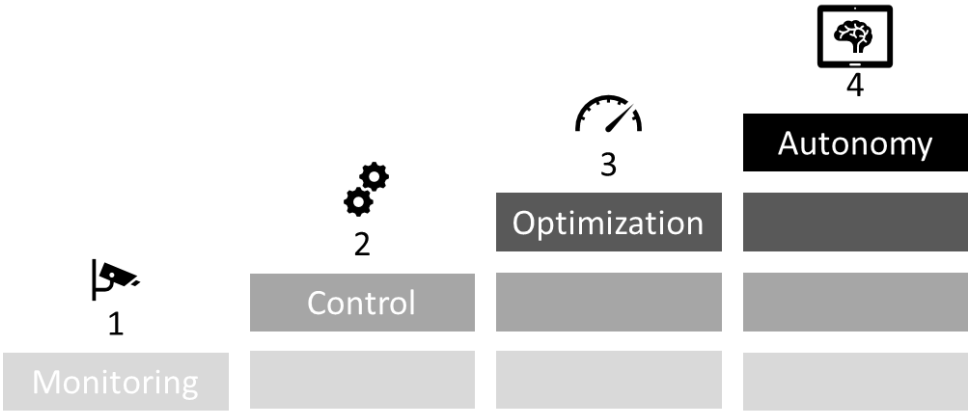

Figure 6 Capabilities of the IIoT adapted from (Porter & Heppelmann 2014).

Monitoring offerings enable product's condition monitoring using sensors and external data sources. By using monitoring the company can adjust product's operations and fix problems. Monitoring allows company to better understand how the product is used. *Control* offerings allow products to be controlled through remote commands or algorithms. Algorithms control the products when some changes happened in conditions or environment based on preset rules. *Optimization* is remote adjusting of product based on monitored data. *Autonomy* offerings compound monitoring, control and optimization with autonomous product. The product can monitor its environment, control itself, and optimize its processes without human interaction. (Porter & Heppelmann 2014)

3.4 Roles of the Internet of Thing companies

Burkitt (2014) remarks that in order to develop an IoT strategy, the company must identify its own role in the IoT context. Klein et al. (2017) have identified four roles of the IoT companies: Enablers, Engagers, Enhancers and Embedders. Roles of the IoT companies are presented in Figure 7.

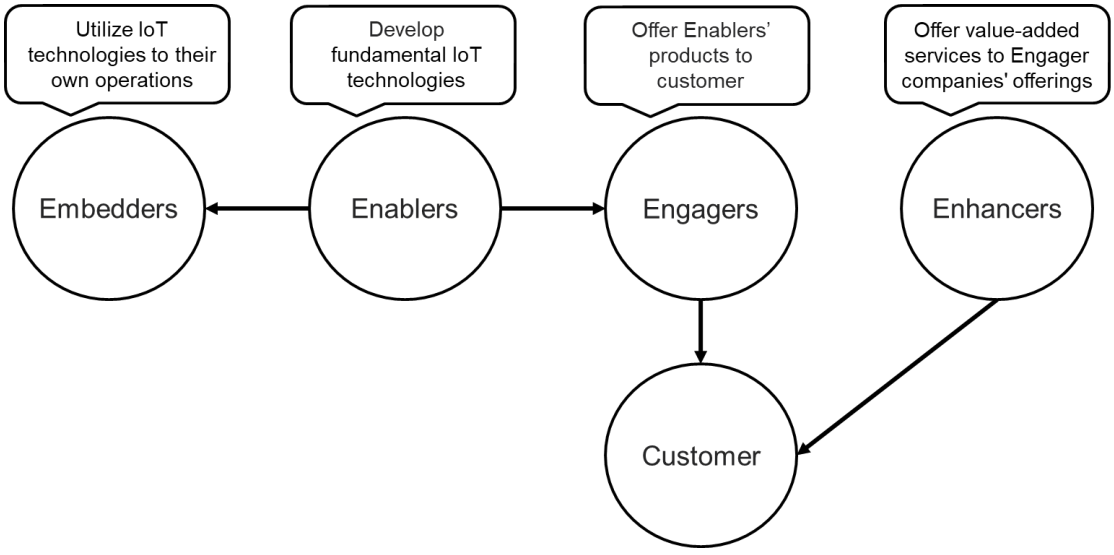

Figure 7 Roles of the IoT companies.

Enablers are companies which develop, implement and maintain the fundamental IoT technologies. Enablers are usually technology-oriented companies. They offer for example the endpoints, hubs, network and cloud service technologies. (Burkitt 2014) Other roles uses Enablers offerings in order to provide their own products.

Engagers are companies which use offerings created by Enablers to create IoT products/services for their customers. Engager companies are usually from non-IT industries such as manufacturing or insurance. Engagers converts physical world events in digital world. (Saarikko et al. 2017) The most successful Engager companies are the ones which have the right capabilities. Engagers needs strong customer relationships to succeed. (Burkitt 2014)

Enhancers are companies which offer value-added services to Engager companies' offerings. Enhancers create value by finding new ways to create and extract value from the data, relationships and insights generated by the IoT products. They integrate services or repackage products. (Burkitt 2014) According to Saarikko et al. (2017) Enhancers filters, aggregates and analyzes generated data to create useful services.

Embedders are companies which utilize IoT technologies to their own operations and business processes (Klein et al. 2017). These companies do not offer IoT products to the customers but use those to improve its own operations and processes (Burkitt 2014).

3.5 Benefits of the Industrial Internet of Things

The value creation of the IIoT can be based on efficiency, complementarities, lock-in or novelty. Efficiency is basically tied to cost reduction of customer. Complementarities offer customer additional products or services. Lock-in ties customer to value chain in a way that creates value for customer. Novelty as a value creation method is creating new offerings or entering to new markets. (Hognelid & Kalling 2015)

According to Toor (2017) the company can make up to 60-70% cost savings by utilizing the IIoT. Savings can be made in inventory, quality, logistics, complexity, and maintenance operations. By implementing the IIoT the company can reduce the wastage of resources and prototyping costs. When the company knows its customers' needs better it does not waste resources on prototyping something that does not meet the needs. The IIoT also enables creating more customized offering to mass markets. The offerings can be customized for customer's needs without additional costs (Toor 2017). In a similar fashion, the IIoT enables engineers to collect feedback from production and products and improve them for next generation (Song et al. 2017 p. 8). The IIoT also increases the transaction volume for existing customers by enhancing repeat usage and customer retention (Cevik et al. 2018).

The improved offering quality can be directly linked to increasing profitability of the company. It has also indirect effects when company's customer satisfaction increases. Thoben et al. (2017) argues also that the IIoT increases sustainability and efficiency. They also claim that company's agility and resilience improve due to the IIoT. The company can more easily adapt to environmental changes. The IIoT is also linked to energy savings of the company while the company can more easily observe and adjust its processes and optimize them. (Thoben et al. 2017)

The IIoT increases company's competitiveness based on an innovative offering. The company can expand and protect its market share and improves its strategic differentiation. Implementing the IIoT may grow sales volumes and reduce cost. It can improve overall equipment effectiveness and resource efficiency by lowering failure rates and reducing manual activities. The IIoT enables time reductions in the production and supply chain. Set up times are shorter and production in general is faster. Moreover, time-to-market time decreases due to improved R&D. Time used in non-value-adding activities can be reduced. (Kiel et al. 2017)

Furthermore, implementing the IIoT increases company's profit and revenue flow, lowers operational cost, improves operational processes and enables remote asset management and predictive maintenance. The IIoT decreases the need of workforce, which decreases operational cost and increases profit. At the same time, it naturally decreases possibilities of human errors and variation in operation processes. Remote asset management enable centralizing services which again decreases the need of workforce. Predictive maintenance prevents unexpected shutdowns of the machines which save time and money. (Gilchrist 2016 pp. 8-10.) Finally, Gilchrist (2016 pp. 8-10.) remarks that the quickest results and return of investment can be achieved through remote asset management and predictive maintenance.

Chevik (2018) remarks that the whole supply chain benefits from the IIoT and not just the company which implements it. The IIoT shortens testing processes and increases quality, flexibility and efficiency on whole supply chain. Kiel et al. (2017) support the idea and says the IIoT enables sharing information flow within value chain. It changes processes, stock and logistics data to a more transparent form.

According to Gilchrist (2016 pp. 8-10.) in the traditional manufacturing industry the added value can be based on quality, price, quantity, or perceived value for the money. However, these value-adding strategies are not long-term due to a low entry barrier. It is easy for competitors to conduct the same improvements. The IIoT has health and safety benefits for several industries as well as the reduction of the need of local team support. (Gilchrist 2016 pp. 8-10.) Furthermore, Kiel et al. (2017) add that the IIoT benefits human resources by simplifying processes, optimizing human-machine interaction and improving security of employments.

Especially the health care industry, which involves a lot of technology but also interaction with human, benefits from the IIoT. The IIoT improves customer care and quality of service. Diagnoses are more accurate and reliable, and the information can be shared between professionals. The IIoT helps monitoring and enables quicker processes. (Gilchrist 2016 pp. 8-10.)

3.6 Challenges of the Industrial Internet of Things

Traditionally manufacturing companies have focused on the fabrication or assembly and generated revenues by selling physical products. Naturally this implies that the major part of costs consists of material, machine and labor cost. In the era of the IIoT the companies extend their offering to services and expand their role in the value chain. This change not only their offering and cost structure but also the whole business model of the company. (Thoben et al. 2017)

The IIoT allows companies to create new service offerings like condition monitoring and predictive maintenance. Hence, the company can offer individual service package and address new customer segments. (Arnold et al. 2017a) Likewise Engström & Skoglund (2017) remark that the IIoT allows companies to generate data and information which can be commercialized through a new product, service or partnerships. In addition, an IIoT platforms can also be a new offering of a manufacturing company (Cevik et al. 2018).

Similarly, the number of competitors might increase as when the company enters new markets with new offerings (Klein et al. 2017). The markets are changing due to new novel business areas on IIoT. Industry boundaries are changing and entry barriers to IT-driven industry are rather low. Industry-spanning concentration on IIoT is becoming more common. (Kiel et al. 2017) To conclude, Porter & Heppelmann (2014) argue that the IIoT is not only reshaping competition within an industry but it is reshaping the industry itself too.

According to Klein et al. (2017) a company should define the value proposition for the customer, but the demands and expectations of the customer are hard to identify. The IIoT helps companies to know what the customers' needs are by gaining more knowledge of how the product is used (Porter & Heppelmann (2014). Moreover, the company needs to find a value proposition for all the actors involved in the ecosystem. While the number of actors in the ecosystem increases the complexity of coordinating increases as well. The IIoT drives companies towards partnership-based ecosystem where value is co-created. (Klein et al. 2017) However, Kiel et al. (2017) argue that required openness, trust and technological compatibility between companies is hard to achieve. Moreover, it is challenging to involve customer into the ecosystem.

The IIoT changes manufacturing companies towards data-driven companies. The data includes many variables. It is challenging to store and analyze large amount of data. Also, the monetization of the data is difficult and hard to forecast. Finally, the company must consider the privacy issue of the data. (Klein et al. 2017) The information security is one reason why the IIoT is adopted quite slowly at the moment (Tripathi 2015). Kiel et al. (2017) agree and continue by saying that the company must considerer information security in vertical and horizontal connections through the entire value chain. Risk of cybercrimes and industrial spying increases due to the connectiveness.

Regional differences are a challenge of their own for the IIoT. Different countries have different rules and regulation about data ownerships. In addition, the bandwidth and the speed of the internet can differ. Also, the organization culture affects implementing the IIoT. Implementing new technology and processes is always challenging. (Kiel et al. 2017) Some organizations are more open to change and new IT systems while in other organizations new implementations causes extensive resistance. Moreover, small organizations are more flexible for the changes while in big organization the change might be costly and take a long time.

Implementing the IIoT is risky because the profitability is still uncertain. The IIoT development needs high investment but the revenues might be unclear. (Kiel et al. 2017) Lack of budget might be s challenge for many companies (Tripathi 2015). In addition, the complexity of the IIoT technology creates new kind of challenges for the company (Klein et al. 2017). Similarly, Kiel et al. (2017) adds that immature technology can threaten product and process quality. Profitable IIoT investment needs IIoT-centered business models with

a value-adding focus and following right IIoT trends (Kiel et al. 2017). Lastly, the legacy systems complicate the implementation of the IIoT systems (Tripathi 2015).

4. BUSINESS MODEL

The business model term is rather old and dates back to 1957 (Wirtz et al. 2016). According to Wirtz et al. (2016) there still is not clear explanation on how business model work. However, the literature is full of different types of business models and tools for defining the business model for a company.

This chapter introduces basic principles of a business model. First the business model is defined from different perspectives. Next the business model development is explained and answered the first sub-question. Then the Business Model Canvas, a widely accepted tool for defining the business model for the company is presented. Finally, business model patterns are introduced.

4.1 The definition of a business model

There are several definitions for a business model in a literary. Gassmann et al. (2013) call business model as a term which compounds different business components into a whole, in other words, how business in company works. In turn, Osterwalder & Pigneur (2010) describes business model as a logic for creating, delivering and capturing value in an organization. On the contrary, Montanus (2016) describes business model as a template for creating value for company's customers. Business model forms company's money earning logic, but it should not be confused for company's strategy (Montanus 2016). Finally, Osterwalder (2004) describes business model as a layer between business strategy and processes which is presented in Figure 8.

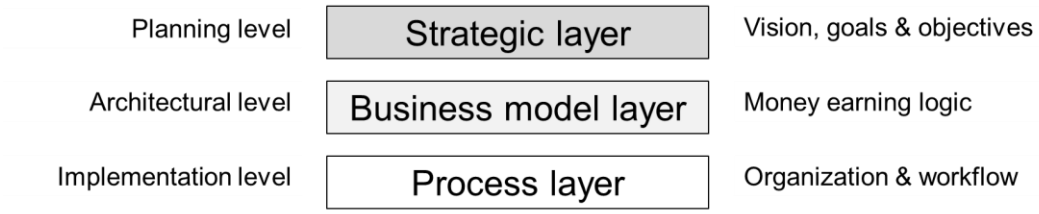

Figure 8 Business model layer presentation adapted from (Osterwalder 2004).

Although there is a lot of variation in definitions of business models, there is also a lot of similarities within business models in the literature. According to Wirtz et al. (2016) almost all existing literature considers business models from a static perspective. The business models describe the business as a state rather than a change. Business model definitions focus on compiling and simplifying the company's relevant activities. It describes how company's offerings are created but also examines customers and market. (Wirtz et al. 2016)

The components of the business models are rather similar, but the degree of abstraction differs between models. All components of the different business models are: strategy, resources, network, customers, market offering, revenues, service provision, procurement and finances. However, none of the models Wirtz et al (2016) studied includes all the components.

Also, Gassmann et al. (2013) remark that there is not a common opinion on which parts the business model is formed. They use rather simplistic four-dimension concept which consist of Who, What, How and Value components. The Who component answers the question "who your target customer is". The What component answers the question "what you offer to the customer". The How component answer the question "how is the value proposition created". The Value component answer the question "how is the revenue created". Gassmann et al. (2013) four-dimensional business model concept is presented in Figure 9.

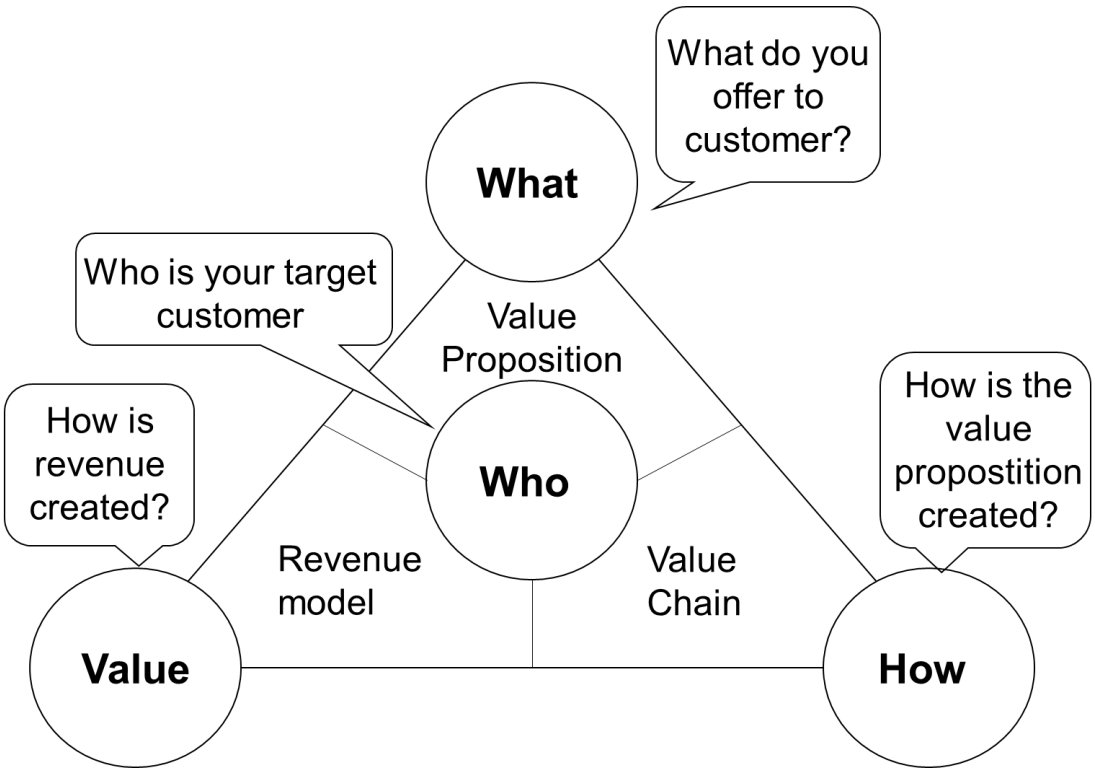

Figure 9 Business model definition – the magic triangle adapted from (Gassmann et al. 2013).

However, Gassmann et al. (2013) remark that in the real world the business model of a company is always much more complex because there is a vast number of factors which affects company's business.

According to Osterwalder et al. (2005 pp. 8-11.) business models can be divided into three levels: meta-models, taxonomies and instances. First level, meta-models, views the definitions of a business model. This level sees the business model as an abstract concept. Second level, taxonomies, consists of generic business models which have common characteristics. Third level, instances, presents real world business models.

4.2 Business model development

There are a lot of definitions for the business model and it is hard say which one is the right definition. There is probably not just one right definition for the business model, but it depends on the context which model suits best. However, it is important for the company to implement business model for their context and transform it into a useful tool.

A business model framework is a model whereby the company can identify relation between their current business model and its potential. Thus, the company can define what steps it should take to achieve the wanted state. Business model framework helps to identify where company's business is right now. (Chesbrough 2007) Similarly, Burmeister et al. (2016) call this activity to business model innovation. According to them, the business model innovation is recognizing, capturing and reconfiguring skills needed to adapt to the changing business environment. In other words, it is a way to find new ways to create and capture value. According to Wirtz et al. (2016) a new sustainable competitive advantage can only be acquired with business model reinvention and not just continuous improvement.

There are seven popular and well-published business model frameworks: The Business Model Canvas, The Four-Box Business Model, The STOF mode, Business Model Schematics, Technology/market mediation, Entrepreneur's business model, e3-value. There are significant similarities between the frameworks and there is not a great relevance which framework is used. (Fielt 2011) The Business Model Canvas is chosen for this research due to its popularity and wide acceptance.

4.3 Business Model Canvas

Business Model Canvas is a tool for describing and designing business model. It is developed by Alexander Osterwalder and Yves Pigneu. (Alias et al. 2015) Business Model Canvas is a widely adopted business model framework. The Business Model Generation book has been sold over 100 000 copies and it is listed among the best-selling business books many times. Creation of the book was cooperation of 470 practitioners. (Fielt 2011)

Business Model Canvas consist of nine components which are: key partners, key activities, key resources, value propositions, customer relationships, channels, customer segments, cost structure and revenue streams. The elements can be divided on Gassmann et al. (2013) four dimensions: Who (customer), What (offer), How (infrastructure) and Value (finance) components. (Osterwalder & Pigneur 2010) The Business Model Canvas divided in four-dimension is presented in Figure 10.

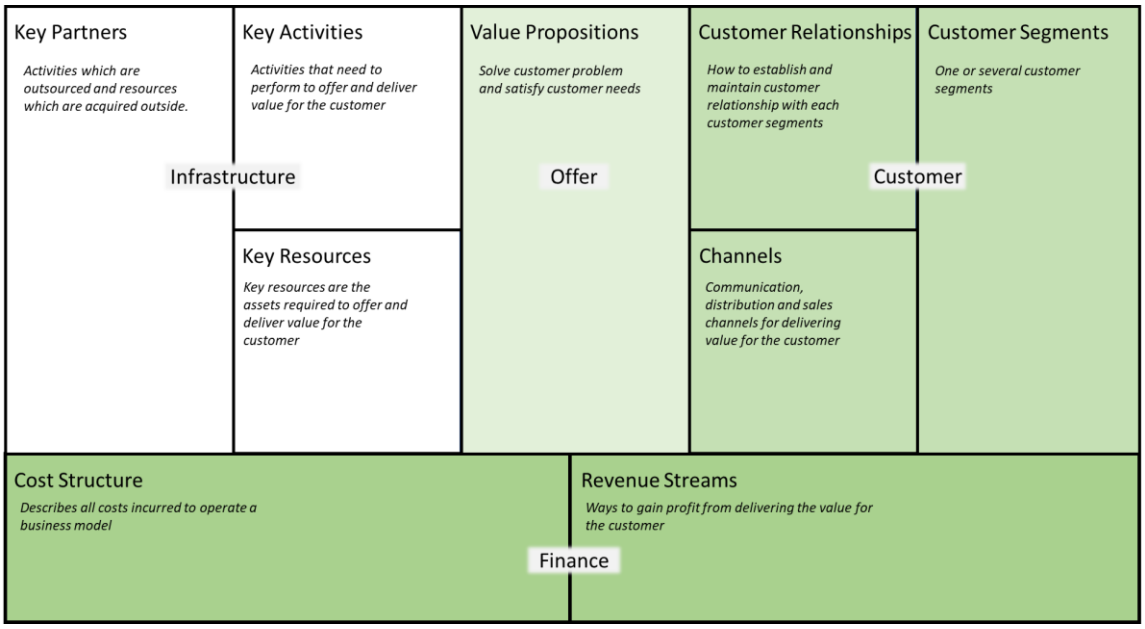

Figure 10 Business Model Canvas adapted from (Osterwalder & Pigneur 2010).

However, Arnold et al. (2016) remark that components or dimensions of the Business Model Canvas are not separate units but tightly connected. The connections between the components are presented in Figure 11.

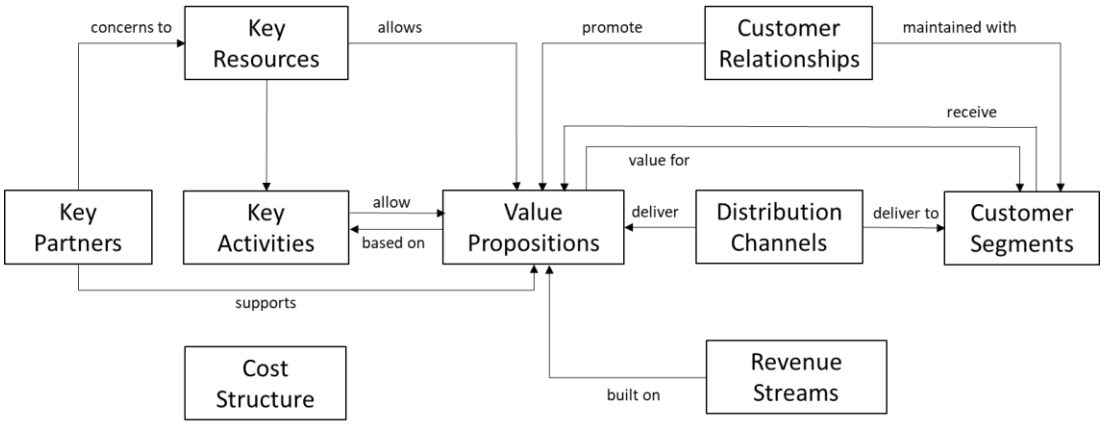

Figure 11 Connections between business model components adapted from (Arnold et al. 2016).

Although the cost structure has been left separately in the figure, it is connected to all the components and it is an enabler for the whole business model. The descriptions of the components are presented in Table 3.

Table 3 Business Model Canvas components (Osterwalder & Pigneur 2010).

Component	Description	Possible categories
Key Partners	*Partners for whom the activities have been outsourced and from whom the resources are acquired.*	*Optimization and economy of scale, Reduction of risk and uncertainty, Acquisition of particular resources and activities.*

Key Activities	*Activities that need to perform to offer and deliver value for the customer.*	*Production,* *Problem solving,* *Platform/Network.*
Key Resources	*Key resources are the assets required to offer and deliver value for the customer.*	*Physical,* *Intellectual,* *Human,* *Financial.*
Value Propositions	*Solve customer problem and satisfy customer needs.*	*Newness,* *Performance,* *Customization,* *'Getting the job done',* *Design,* *Brand/status,* *Price,* *Cost reduction,* *Risk reduction,* *Accessibility,* *Convenience/Usability.*
Customer Relationships	*How to establish and maintain customer relationship with each customer segments.*	*Personal assistance,* *Dedicated personal assistance,* *Self-service,* *Automated services,* *Communities,* *Co-creation.*
Channels	*Communication, distribution and sales channels for delivering value for the customer.*	*Sales force,* *Web sales,* *Own stores,* *Partner stores,* *Wholesaler.*
Customer Segments	*One or several customer segments.*	*Mass market,* *Niche market,* *Segmented,* *Diversified,* *Multi-sided platforms.*
Cost Structure	*Describes all costs incurred to operate a business model.*	*Fixed costs,* *Variable costs,* *Economy of scale,* *Economy of scope.*
Revenue Streams	*Ways to gain profit from delivering the value for the customer.*	*Asset sales,* *Usage fee,* *Subscription fees,* *Lending/Renting/Leasing,* *Licensing,* *Borage fees,* *Advertising.*

According to Osterwalder & Pigneur (2010) the best way to work with the Business Model Canvas is to print it on a large paper and write down components on Post-it® notes with a group of people. They introduce six ways to design business models: ideation, customer insight, prototyping, visual thinking, scenarios and storytelling. For example, in

ideation the team can approach the business model from five perspectives: finance driven, customer driven, resource-driven, offer driven or multiple-epicenter driven perspective. This tells which dimension guides the ideation. For example, in resource driven ideation the business model based on a company's existing infrastructure and partnerships. (Osterwalder & Pigneur 2010)

4.4 Business model patterns

When reviewing different business models, there can be identified similar characteristics between them. These characteristics are called business model patterns. While the Business Model Canvas describes the components of the business model, the business model patterns describe business models which have similar characteristics. Osterwalder et al. (2010) introduced 5 business model patterns: Unbundling Business Models, The Long Tail, Multi-Sided Platforms, Free as a Business model and Open Business Models. In the unbundling business models, the business focuses on customer relationships, product innovation or infrastructure. In other words, the company focuses on customer intimacy, product leadership or operational excellence without trade-offs.

The Long Tail business models aggregate sales on selling large scope of niche content. This business model requires low inventory costs and strong platforms. The platform is essential part of this business model's key activities and resources. In the Long Tail business model, the company must have lot of niche customers. (Osterwalder & Pigneur 2010)

Multi-sided platforms bring together two or more customer segments and value is created to the one if the another is also in the platform. Multi-sided platforms for example links end-users and developers. A good example is Google, which offers free search for customers by showing them advertisements which they have sold to another customer segment. Multi-sided platforms need own value propositions for each customer segments. Also, the revenue stream is different depending on the customer segment. (Osterwalder & Pigneur 2010)

In a business model pattern called Free, the product is served to at least one customer segment for free. Giving something for free is a highly attractive value proposition. An example of this free model are multi-sided platforms. Another example is freemium where basic service is free but some customers pay for the premium service. (Osterwalder & Pigneur 2010)

In Open Business Models, the company creates value by collaborating with outside partners. Open business model can be either, Outside-In or Inside-Out pattern. In the first one the company buys innovation from outside and in latter one the company sell innovation to other partners. (Osterwalder & Pigneur 2010)

In addition to these five business model patterns there are lots of others. For example, Gassmann et al. (2013) have identified 55 business model patterns. Business model patterns are not separate entities but usually a single business model consist of several patterns (Osterwalder & Pigneur 2010). However, business model patterns alone will not give detailed picture of the company's business and the company needs some tools like the Business Model Canvas to clarify if their business model fit in to some pattern or if it is unique.

5. BUSINESS MODELS IN THE INDUSTRIAL INTERNET OF THINGS

Traditional business models of the manufacturing industry are under high-pressure due to the Industrial Internet of Things. The IIoT changes manufacturing industry's value creation methods (Schaefer 2017). Thus, companies have to redesign their business models to meet the needs of the IIoT.

This chapter studies IIoT-driven business models presented in the literature. In this chapter, the business models of the Industrial internet of things are studied through 23 articles which are introduced in Table 4.

Table 4 The Industrial Internet of Things business model literature.

Title	Source	Method	Goal
Internet of things-based products - services, process and challenges on developing the business models	(Klein et al. 2017)	Literature review / Action research	Investigates what elements affect creating a business model for IoT-based products/services and what challenges there are.
Industry 4.0 as smart enabler for innovative business models	(Toor 2017)	Multiple case study	Investigates IIoT related effects on the business models regarding the manufacturing industry from a Tech-based consultancy point of view.
Prototyping Business Models for IoT Service	(Ju et al. 2016)	Literature review / Interviews	Develop a generic business model framework for IoT business using interviews and literature analysis.
Business models for the Internet of Things	(Dijkman et al. 2015)	Literature review / Interviews / Survey	Identifies the relevant building blocks for an Internet of Things business model and provides a business model framework specially for Internet of Things applications.
Innovative Business Models for the Industrial Internet of Things	(Arnold et al. 2017b)	Systematic literature review	Introduces novel and innovative IIoT business models and assigns them to three generic business models types.
Smart and Connected Product Business Models	(Cevik et al. 2018)	Literature review	Defines the key features of a smart and connected product business models and studies the successful real-life cases with this framework.
The Impact of the Industrial Internet of Things on Established Business Models	(Arnold, Kiel, Voigt & Collisi 2016)	Systematic literature review	Studies the impact of the IIoT on business models of well-known manufacturers.

The influence of the Industrial Internet of Things on business models of established manufacturing companies – A business level perspective	(Arnold et al. 2017a)	Multiple case study	Analyses the impact of the IIoT to business models from a business level point of view, and focuses on the relationships between changes in business model components.
What firms need to consider when adapting their business models for IoT	(Engström & Skoglund 2017)	Multiple case study	Studies companies transformation that they might go through while implementing IoT.
How Industry 4.0 changes business models in different manufacturing industries	(Arnold et al. 2016)	Multiple case study	Analyses the impact of the IIoT to business models with specific respect to differences and similarities dependent on varying industry sectors.
IoT business models in an industrial context	(Weinberger et al. 2016)	Journal article	Introduces concept of high-resolution management (HRM) and studies business model patterns of the IoT in an industry context.
Unlocking value from machines: business models and the industrial internet of things	(Ehret & Wirtz 2017)	Literature review	Studies the opportunities and threats the IIoT offers of business models. Introduces three business models.
A Data-Driven Business Model Framework for Value Capture in Industry 4.0	(Schaefer et al. 2017)	Conference proceeding	Analyzes four case studies of data-driven business models through a SWOT analysis.
Business Model Innovation for Industrie 4.0: Why the "Industrial Internet" Mandates a New Perspective on Innovation	(Burmeister et al. 2016)	Exploratory research design	Analyzes 140 business model characteristics. Introduce processes, structures and tools for business model innovation in the industry 4.0. Derives also upcoming practices.
Integration of Internet of Things components into a firm's offering portfolio – a business development framework	(Gerpott & May 2016)	Case study	Studies suitability of IoT-enhanced offering against company's current portfolio.
Internet of Things and Business Models	(Hognelid & Kalling 2015)	Case study	Analyzes the IoT's impact on business models and value creation sources using a proposed framework to empirical context.
Internet of Things Business Models	(Chan 2015)	Multiple case study	Proposes IoT business model using three-dimension model: Who, Where, Why.
Smart Data Pricing Models for the Internet of Things: A Bundling Strategy Approach	(Niyato et al. 2016)	Journal article	Studies data management in IoT using a smart data pricing approach. Propose new pricing schemes for IoT service providers.

Toward Ecosystemic Business Models in the Context of Industrial Internet	(Iivari et al. 2016)	Journal article	Studies IIoT business models in the ecosystem viewpoint.
Designing Business Models in the Era of Internet of Things	(Westerlund et al. 2014)	Design science research	Proposes a business model framework specified for IoT-driven ecosystem.
Business Models for Industry 4.0 Developing A Framework to Determine and Assess Impacts on Business Models in The Dutch Oil and Gas Industry	(Montanus 2016)	Thesis	Designs a framework whereby the company can evaluate the impacts of Industry 4.0 on business models.
Capturing Value from Data: Revenue Models for Data-Driven Services	(Schüritz et al. 2017)	Conference proceeding	Introduces possible data-driven service revenue models based on 100 start-ups.
What Do We Know About "Industry 4.0" So Far?	(Kiel 2017)	Conference proceeding	Studies the current state of economic research of the IIoT through systematic literature review and identifies research gaps in the field of the IIoT.

First subchapter studies the business models of the IIoT using Business Model Canvas. In the first subchapter, the following sub-question is also answered:

- *Which business model characteristics are appropriate for a manufacturing company's IIoT software solutions?*

Second subchapter introduces IIoT business model patterns presented in the literature. Finally, the following sub-question is answered:

- *What challenges does the business environment causes for implementing such a business model?*

5.1 Business Model Canvas of the Industrial internet of things

The components of the IIoT business models are first studied individually and finally findings are summarized and evaluated.

5.1.1 Key Partners

The key partners of the business model are likely to change due to the IIoT. (Engström & Skoglund 2017) Porter & Heppelmann (2014) complement this idea and say that the IIoT is changing supplier relationships as the value of the software is increasing and relative value of physical product decreasing. Furthermore, due to the IIoT the company must create new supplier relationships.

According to Arnold, et al (2016) the key partners are one of the most affected components of business models. However, Engström & Skoglund (2017) remark that the effect of the IIoT depends on earlier context of the company. Partnerships are becoming more important than ever since all the know-how isn't available in one place (Hognelid & Kalling 2015; Burmeister et al. 2016). The need of new IT skills and analytics partners rises and company must recognize which capabilities should be developed in-house and what should be outsourced. The company must acquire new and re-train current employees. (Klein et al. 2017) To conclude, Kiel et al. (2017) remark that implementing intra-firm and inter-firm connection is a challenging task.

In the era of the IIoT the development of new offerings becomes more cooperative. Companies are not creating offerings alone anymore but with cooperation of partners and customers. The company cannot afford to rely on their own research but they should buy or license processes and innovations outside. Therefore, also the complexity of the product development has increased. Key partners and customer relationships have become major components of company's business model. (Thames & Schaefer 2017)

Arnold et al. (2016) argue that especially IT suppliers are new key partners of the IIoT-driven company. The need of technology developer partnerships increases. Especially if the company doesn't have internal skills to develop its IIoT systems, it needs to outsource all or partition of the development. (Klein et al. 2017) Toor (2017) agrees and adds also relationships with specialized analysts. The company needs data analytics skills in order to turn data into useful information. Both Engström & Skoglund (2017) and Ju et al. (2016) fine down the partnerships to concern software developers, data analytics companies and device manufacturers.

Customers have become key partners of the IIoT company. Customers are collaborative partners which are involved in developing the products. Co-design and open innovation processes are activities in which the customer participates company's operations. (Arnold et al. 2016; Schaefer et al. 2017; Arnold et al. 2017a) However, Arnold et al (2017a) point out that usually manufacturers rather use their own know-how and key activities than external partners.

A manufacturing companies are not the only ones creating value for a customer but rather all collaborators (Westerlund et al. 2014; Chan 2015). One new form of partnership is closer relations in the value chain or the ecosystem. Distributors, logistics and service partners are a few examples of value chain actors. (Dijkman et al. 2015; Iivari et al. 2016) Schaefer et al. (2017) have noticed in their case study that strategic alliances are a common key partner for every IIoT-driven companies.

However, Engström & Skoglund (2017) argue that the creation of new partnerships depends on the willingness of sharing data. Usually companies aren't anxious to share their data. For example, data integrity has become an issue because companies are dependent on each other's security systems and vulnerability of one's system affects the other companies' systems as well. Engström & Skoglund (2017) summarize that in order to create new and valuable partnerships, the company has to identify its place in an IIoT ecosystem.

5.1.2 Key Activities

Like the key partners, the key activities are highly affected because of the IIoT (Arnold et al. 2016). Also, the earlier context of the company has a big impact on the key activities.

IT-driven companies don't have to change their key activities in same extent while implementing the IIoT. The IIoT-driven business models' key activities are more digital and software-based compared to physical (Kiel 2017).

Software and product development are key activities of an IIoT-driven company (Engström & Skoglund 2017) Other key activities are collection of data and data analytics (Arnold et al. 2016; Montanus 2016; Toor 2017; Schaefer et al. 2017). The building, tuning and maintaining of the data collection and processing logic of the IIoT are crucial activities for the company. According to Engström & Skoglund (2017) the success of the IIoT company depends on its analytical capabilities.

The company must considerer which activities they have to do for platform. The activities differ depending on who maintains the platform. Possible key activities are platform development and integration. (Dijkman et al. 2015; Ju et al. 2016) Depending on who maintains the platform the company can move these key activities to the supplier. However, the outsourcing raises the need of new activity: partner management (Dijkman et al. 2015; Ju et al. 2016). Skills to take advantage of ICT systems for interaction with partners and customers has become an essential activity. (Arnold et al. 2016A)

Customer integration has risen to a key activity of the IIoT-driven company as the co-designing and co-developing processes have become more common. (Dijkman et al. 2015; Arnold et al. 2016; Toor 2017). Kiel (2017) argues that to succeed the company must integrate with the customer in an early stage of the design and development of new business models. Iivari et al. (2016) remark that the co-creation is not only limited to customers but includes all actors in value chain.

The customer-oriented communication is a crucial activity due to rise in service orientation of all industries (Arnold et al. 2017a). The IoT is highly service oriented and it will change traditional manufacturers' offerings towards service based. The boundaries between products and services are vanishing. (Kiel 2017) Thus the service is one key activity of the IIoT-driven company.

5.1.3 Key Resources

The key resources of IIoT company are physical resources, financial resources, employees, relations, software and other intellectual property, like sensor data. (Dijkman et al. 2015) In addition, one key resource of an IIoT-driven company is the platform (Arnold et al. 2016). Customers and suppliers are increasingly connected with online platform where they exchange their data and information (Kiel 2017). According to Kiel (2017) the data has become one of the most important resource of the IIoT-driven company.

The IIoT implementation forces a company to acquire new employee competencies and skills. (Engström & Skoglund 2017) The role of employees has changed from operators to problem solvers. The employees should have qualification of an IIoT-appropriate adaption. (Arnold et al. 2017a) Moreover, the employees need additional analytical skills (Toor 2017). The know-how and culture of the organization in general are key resources (Arnold et al. 2017a).

Value creation networks can be seen as a key resource of the IIoT-driven company. The purpose of a value creation network is to connect different parts of supply chain via cloud-

based platform. It creates responsive real-time environment and helps to improve the flexibility of value propositions. (Westerlund et al. 2014; Arnold et al. 2016; Toor 2017)

Arnold et al. (2016) argue that high levels of software integration into traditional production systems and processes is a key resource. The better you can integrate the IIoT into the system the better results you get. Finally, Schaefer et al. (2017) add after sales service to be a key resource.

5.1.4 Value Propositions

The value propositions are the most affected business model component in the IIoT implementation (Arnold et al. 2016). It is essential that the company has a clear value propositions which are based on customer's needs, profile and level of familiarity with the technology. A good way to understand customer's needs and complexity of the IIoT is experimenting pilot projects. (Klein et al. 2017)

Ju et al. (2016) divide the IIoT value propositions into three classes: convenience, performance and customization. Convenience solutions ease users' processes and usage of products. Performance solutions intensify users' products and processes. Customization solutions enable users to modify the products. Klein et al. (2017) say that convenience solutions can be provided through service and it is essential part of the IIoT value offering.

The IIoT can either change an existing offering or create a new offering (Engström & Skoglund 2017). According to Arnold et al. (2017a) new offerings are based on data mining and analytics. New offerings may be products, services or solution packages. In turn, the change of the existing offering is based on optimization. Optimization of the existing offering can lead e.g. reduction of cost or time, reliability, quality and efficiency. Montanus (2016) claims that new services are based on data, information and connected supply chain. Changes of existing services can be combinations of company's existing services and partners' services. Arnold et al. (2017a) lists value propositions of the IIoT offerings:

Table 5 Value propositions of the IIoT offerings (Arnold et al. 2017a).

High level concept	Value proposition
Automation	Time, energy, and resource efficiency Machine availability Overall equipment effectiveness Process simplification Productivity
Augmented reality	Condition monitoring Hybrid solutions IIoT-readiness Predictive maintenance Service packages

Data analysis	Data collection Data consistency Data processing Data traceability Data transparency Data utilization
Machine communication	Machine diagnostics Operating hours Quality management
Cost reduction	Cost savings
Flexibilization of production	Modularity Individualization
Machine handling; usability	Workplace ergonomics
Customer retention	Lifelong support

Dijkman et al. (2015) adds to this list: newness, design, brand/status, risk reduction and possibility for updates. In addition, Klein et al. (2017) reminds that the privacy issue is essential part of the IIoT offering.

5.1.5 Customer Relationships

The nature of customer relationships changes along with the implementation of the IIoT. The relationship between the company and customer tightens. According to Engström & Skoglund (2017) co-creation is occurring when two companies share data in a way that will benefit them both. Especially the co-creation needs high collaboration and integration levels. Furthermore, the integration should be as transparent as possible. (Westerlund et al. 2014; Dijkman et al. 2015; Ju et al. 2016; Arnold et al. 2016; Iivari et al. 2016; Toor 2017)

Due to high complexity of the new IIoT-based offering solutions, communication must increase in both ways. The customer incorporates more into the company's development activities. New offerings are created in co-operation with the customer which needs effective communication between companies. Thus, both companies have to rethink their contact people so that they can communicate effectively and build trust between the companies (Arnold et al. 2016; Arnold et al. 2017a). According to Engström & Skoglund (2017) tightened customer relationship can lead to entire ecosystems which can create new value for both.

Usually, IIoT-driven companies' customer relationships are focusing on either communities or self-service (Dijkman et al. 2015). The IIoT enables the self-reliance of the customer and usage of self-service. New ways to communicate are social media and online communities. (Arnold et al. 2016; Schaefer et al. 2017; Toor 2017). In addition to self-service Dijkman et al. (2015) adds that the customer might need personal assistance.

5.1.6 Channels

Implantation of the IIoT won't have a big impact on a company's channels (Arnold et al. 2016). New ways to delivering the value are e-commerce and interactive online markets (Arnold et al. 2016; Toor 2017). Engström & Skoglund (2017) argue that the IIoT can change the sales towards more web-based direction. Ju et al. (2016) agree and state that new distribution channels are internet and mobile. The usage of social media and online communities will be increase as a way to delivering the value for customers. Especially emails will be replaced (Toor 2017).

Arnold et al. (2017a) divide channels to direct and indirect sales. They argue that direct sales are more probable for the IIoT companies, due to high need for customer consultation. Dijkman et al. (2015) lists distribution channels for the IIoT: sales force, web sales, own stores, partner stores, wholesaler. Klein et al. (2017) claims that partner's channels in general can be also utilized. Schaefer et al. (2017) remind that existing customer base and repeat business remain strong channels.

5.1.7 Customer Segments

The customer segments are least affected components of the Business Model Canvas in the IIoT implementation (Arnold et al. 2016). There are hardly any new target customers addressed (Arnold et al. 2017a). However, it is widely accepted that the IIoT implementation might create new markets (Arnold et al. 2016; Ju et al. 2016; Burmeister et al. 2016; Toor 2017; Arnold et al. 2017a). For example, the company can create new information out of the collected data and sell that.

Still Engström & Skoglund (2017) argue that it is unclear if the IIoT adds segments or changes company's current segmentation. In any case the IIoT has changed the current offering so is it changing the way a company segments its customers. Dijkman et al. (2015) list possible market segments: mass market, niche market, segmented market, diversified market and multi-sided markets. According to Porter & Heppelmann (2014) segmented market means that the company has different customer segments with slightly different problems and needs. Diversified market means that the company serves two or more unrelated customer segments with very different problems and needs. For example, Amazon started to sell cloud computing services in addition to books. If company serves multi-sided markets, it serves two or more independent customer segments. For example, newspaper is offered for free in order to attract large amount of readers which in turn attracts advertisers. The advertisers again finance the newspaper.

According to Burmeister et al. (2016) new trend in the B2B market is so called B2B2C which means that the company thinks about the end-customer when designing new offerings for its customers. Data generated by the IIoT system make it possible to B2B company achieve knowledge from end-customer. However, this require close partnership with the customer.

5.1.8 Cost Structures

The implementation of the IIoT changes company's cost structure. According to Dijkman et al. (2015) the IIoT cost consist of product development, IT cost, personnel cost, hardware/production cost, logistics cost and marketing & sales cost. Arnold et al. (2017a) add

partner integration cost to this list. However, Engström & Skoglund (2017) point out that the company should focus on their own cost structure and not confuse it with cost reduction in the value proposition. In the other words, the IIoT changes both the company's and the customer's cost structures and the company should focus on their own cost structure.

Personnel cost will probably rise because the company must hire highly skilled employees (Arnold et al. 2016). However, this depends on the company's earlier context and competencies (Engström & Skoglund (2017). Moreover, the company must consider if they should hire certain people or outsource the activity.

IT cost is formed because the usage of IT resources increases (Engström & Skoglund 2017). IT costs consist of developing and maintaining both software and platform. Moreover, the maintenance creates service costs. (Arnold et al. 2017a) Schaefer et al. (2017) remind that the IIoT needs upfront investment and the products are usually scalable which reduce unit costs.

5.1.9 Revenue Streams

The IIoT enables companies to generate new novel revenues streams (Arnold et al. 2016). For example, Engström & Skoglund (2017) say that the data created by the IIoT helps company to form revenue streams which are based on a problem solved by the product. According to Dijkman et al. (2015) possible revenue models are:

- Asset sale (Hardware sales),
- Usage fee,
- Subscription fee,
- Lending/renting/leasing,
- Licensing (fees for using external and protected intellectual property),
- Brokerage fee,
- Advertising,
- Startup fee,
- Installation fee.

Arnold et al. (2016) add freemium, multi-sided and add-on revenue models to this list. In addition, there is a commission model where customer pay based on turnover (Arnold et al. (2017a). Toor (2017) divides usage fees to performance-based billing and pay-by-usage models. In performance-based billing the customer is charge based on for example calculating power or storage capacity it uses. In pay-by-usage model the customer is charge based on the time they use the service.

In freemium model, some service is given for free in order to acquire a lot of customers and then offer a premium, paid version of the service which create added value for the customer. In the freemium version, the features, seats, time or customer types can be limited. The feature limited freemium model provide only a basic version of the product. A seat limited freemium model limits the number of users. Time limited freemium model limits the usage of service to certain time period. In a customer type limited freemium model the service is offered for free to some customer segments, such as smaller businesses. (Tagesen 2016)

According to Engström & Skoglund (2017) charge for the uptime of a product as a revenue model will rise instead of traditional subscriptions. However, Arnold et al. (2017a) state that revenue models will hardly change due to the IIoT because of customer resistance, except in a situation where the offering radically changes. Widely adopted model is subscriptions where customers have continuous access to service in exchange of continuous revenue stream. (Arnold et al. 2017a) Engström & Skoglund (2017) have also noticed that companies have difficulties in changing their revenue models. Nonetheless some companies don't even try to change their revenue models. The result of Schaefer et al. (2017) research supports the idea that subscription is the most adopted revenue model.

However, Niyato et al. (2016) remind that before determining revenue model the company must know its cost structure. The company must also determine the customer's willingness-to-pay value.

Dijkman et al. (2015) remark that the IIoT enables creating additional revenues from generated data. According to Schüritz et al. (2017) revenue models of data-driven services are subscription, usage fee, gain sharing and multi-sided revenue models. Subscription is most popular revenue model and it can be either monthly basis or annual model. Many companies offer different subscription models based on functionality or on volume. In usage fee model, the customer pays as they use the service. In gain sharing revenue model, the company is paid based on the performance of the service they provide. This revenue model can be used when the benefits of the service is measurable. (Schüritz et al. 2017)

In multi-sided revenue model, there are at least two different target customer groups. In this model, data and information gathered from one group is a foundation of another group's revenue stream. Multi-sided revenue models can utilize subscription, usage fee and gain sharing model but there are also a few models which can be used only in multi-sided revenue models: advertising, data-tailored offering, buy-and-sell-data and pay-with-data. (Schüritz et al. 2017)

In advertising model, no monetary payment is needed from downstream customer because value is created by exposing upstream customer to them and generating revenue from allowing the upstream customer to advertise. (Schüritz et al. 2017)

In data-tailored offering model the downstream-customer grants access to its private data in order to get tailored offers from upstream-customer. The service provider operates as a platform which enables this interaction. The upstream-customer gains the access by subscription or usage fee model. (Schüritz et al. 2017)

In buy-and-sell-data model the service provider acts as a data broker and there is no interaction between downstream and upstream-customers. The service provider operates with downstream customer in order to find buyer for their data. This model works for companies which are focused on advertising and creation of customer profiles. (Schüritz et al. 2017)

In pay-with-data model the downstream-customer can use the provided service by granting access to their data. The service provider collects and process the data and offer it to upstream-customer, who in turn pays based on subscription or usage fee model. Again, in this model, there is no interaction between downstream and upstream-customers. (Schüritz et al. 2017)

5.1.10 Summary of the IIoT-driven business models

Based on the literature the appropriate characteristics of the IIoT business model for a manufacturing company are summarized in Table 6.

Table 6 Summary of IIoT business model components.

Component		
Key Partners	*Value Chain Partners:* *-Distributors* *-Logistics* *-Service Partners*	*Software Developers* *Data Analytics Companies* *Device Manufacturers* *Customers*
Key Activities	*Software and Product Development* *Data Collection* *Data Analytic* *Service*	*Platform Development* *Partner Management* *Customer Integration*
Key Resources	*Physical Resources* *Financial Resources* *Employees* *Value Creation Networks* *After sales service*	*Software* *Data* *Platform* *Integration level*
Value Propositions	Automation; *-Time, Energy, And Resource Efficiency* *-Machine Availability* *-Overall Equipment Effectiveness* *-Process Simplification* *-Productivity* Augmented Reality; *-Condition Monitoring* *-Hybrid Solutions* *-IIoT-Readiness* *-Predictive Maintenance* *-Service Packages* Data Analysis; *-Data Collection* *-Data Consistency* *-Data Processing* *-Data Traceability* *-Data Transparency* *-Data Utilization*	Machine Communication; *-Machine Diagnostics* *-Operating Hours* *-Quality Management* Cost Reduction; *-Cost Savings* Flexibilization Of Production; *-Modularity* *-Individualization* Machine Handling; Usability; *-Workplace Ergonomics* Customer Retention; *-Lifelong Support* Other: *-Newness* *-Design* *-Brand/Status* *-Risk Reduction* *-Possibility for Updates* *-Privacy Issue*
Customer Relationships	*Co-Creation* *Ecosystems* *Self-Service*	*Social Media and Online Communities* *Personal Assistance*
Channels	*Sales Force* *Web Sales* *Own Stores*	*Wholesaler* *Partner's channels*
Customer Segments	*Mass Market* *Niche Market* *Segmented market*	*Diversified market* *Multi-Sided market (B2B2C)*

Cost Structure	*Product Development* *IT Cost* *Personnel Cost* *Hardware/Production Cost*	*Logistics Cost* *Marketing & Sales Cost* *Partner Integration Cost*
Revenue Streams	*Asset Sale* *Gain Sharing* *Usage Fee* *-Performance-Based Billing* *-Pay-By-Usage* *Subscription Fees* *Lending/Renting/Leasing* *Licensing* *Brokerage Fees*	*Advertising* *Startup Fees* *Installation Fees* *Freemium* *Multi-Sided* *-Data-tailored offering* *-Buy-and-sell-data* *-Pay-with-data* *-Advertising* *Add-On* *Commission Model*

As we can see in general level there is enormous number of characteristics for the IIoT-driven business models and as such the model is not applicable. For example, the value proposition can be almost anything and the company must determine what value propositions its customers value.

Ehret & Wirtz (2017) argues that there are four components of the business model which are relevant for the IIoT context: value proposition, value capturing mechanism, value network and value communication. In the Business Model Canvas, the revenue streams correspond to the value capturing mechanism, key partners correspond to the value network. The value communication is harder to fit in Business Model Canvas because it stands for communication between actors in the value network. However, the customer relationships in the Business Model Canvas correspond to this quite well.

5.2 Business model patterns of the Industrial internet of things

There are several ways to classified IIoT business models. Cevik et al. (2018) divide business models into six groups: remote usage and condition monitoring, digital add-on, digital lock-in, object self-service, product as a point of sales and physical freemium. Weinberger et al. (2016) studies Gassmann's 55 generic business model patterns identifies the same six business models which will be suitable for the IIoT. According to Chan (2015) freemium model is a quite common business model. Descriptions of these six business model patterns are presented in Table 7.

Table 7 Six general IoT business models (Weinberger et al. 2016).

Business model	Description
Digital add-on	A business model where the company offers digital service or product in after-sales phase. The physical product is sold with thin margin and revenue is based on add-ons.
Digital lock-in	A business model where the company tries to increase customer loyalty by for example customizing or improving reliability of the offering.

Product as a point of sales	A business model where the physical products acts as a platform for digital sales. In the other words, digital offerings can be marketed through physical offer.
Physical freemium	A business model which stands for the idea that digital services are free on top of the sold physical good. For example, customer can use the basic services but there is charge from the extended services.
Object self service	A business model in which the machines think independently and for example handles the spare part ordering without human interaction.
Remote usage and condition monitoring	A business model which refers to how offerings can report about their condition or environment in real-time and allows errors to be detected in advance.

Ehret & Wirtz (2017) identify three IIoT-driven business models: asset-driven, service innovation and end-user targeted service-driven. In the asset-driven business model the company owns manufacturing assets and lends them to the customers so customers don't have to own all the assets they need. The IIoT enables changes in models of ownership, e.g. product sharing, product-as-a service and ownership based on performance criteria. The company can sell its both physical and digital products as a service and charge e.g. subscription fees. (Hognelid & Kalling 2015) For example, cranes and lifting company Konecranes have implemented new business model where customers can rent cranes instead of buying them. This allowed Konecranes to enter new markets. (Weinberger et al. 2016) The risk of uncertainty of manufacturing is shifted from customer to service provider. Service innovation business model is based on utilizing analytics in order to create value for customer. End-user targeted service-driven business model is based on personalizing the offer for the customer with co-creation and co-designing. (Ehret & Wirtz 2017)

Arnold et al. (2017b) have divided IIoT-triggered business models into three categories: Cloud-Based business models, Service-oriented business models, Process-oriented business models. Cloud based business models includes Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS) models depending on the company's offering. In the IaaS model, the company offer the infrastructure the customer needs. In the PaaS model, the company offer a platform where the customer can build their own applications. In the SaaS model, the company offer required application via cloud. (Arnold et al. 2017b)

The service-orientated business model offers utilization, analysis, and aggregation of data. The service-orientated business operates on top of IaaS, PaaS or SaaS. Usually, the service-orientated business models provide a self-service interface and automated services to customers. In the process-oriented business models, the company offer process optimization. The process-orientated business operates on top of service-orientated business. The company need great skills and knowhow of the production processes to utilize process-oriented business models. However, process-oriented business models are studied only marginally and all the Business Model Canvas components aren't introduced in the literature. (Arnold et al. 2017b)

5.3 Summary

While designing the IIoT-driven business model, the company must consider its current context and business model and in what capability level it intends to operate: monitoring, control, optimization or autonomy. Moreover, the company must identify what types of an IIoT company it is: an enabler, an embedder, an engager or an enhancer. These factors affect to how the company's business model is formed. However, there are no differences between the IIoT capability levels of the company in the literature. Furthermore, there are not a clear distinction between the types of the companies in the literature

There appeared several challenges in the IIoT-driven business models in the literature. Changing the revenue models is challenging for the company due to the customers' resistance of change. Traditional revenue models might not be profitable to IIoT solutions anymore, but customers are not ready for a new revenue models. Furthermore, implementing the IIoT requires of high upfront investment and R&D costs.

The complexity of the IIoT solutions is a challenge for the company. The complexity requires close customer relationship and effective communicating. Moreover, the company needs skilled workforce to develop the IIoT solutions. Finally, the access to data is challenging because the customers don't want to share their data. The data might be confidential and a key resource of the customer.

To summarize, there are many characteristics affiliated with the IIoT-driven business model. However, one cannot conclude single business model only by looking at the characteristics. The IIoT-driven business model includes several challenges which have to be taken into account while designing the IIoT-driven business model for the manufacturing companies. Moreover, several business model patterns can be defined which are appropriate for the IIoT-driven business. However, business model patterns tend to inspect business models unilaterally from one perspective. We can conclude that there is no "one size fits all" business model for the companies in the IIoT context.

6. FINDINGS

The progress and the results of the empirical research are presented in this chapter. First the empirical research process is presented. Next the results of the empirical research are presented. In second subchapter, the components of the Business Model Canvas are presented and analyzed, and the following sub-question is answered:

- *Which business model characteristics are appropriate for a manufacturing company's IIoT software solutions?*

Finally, the challenges of the business environment are studied and answered the following sub-question:

- *What challenges does the business environment causes for implementing such a business model?*

6.1 Conducting the research

The goal of the empirical research was to reveal and redesign the Industrial Internet department's business model. Moreover, the empirical research seeks to reveal challenges including in the IIoT-driven business models redesign. The empirical research was conducted in the case company using interviewees as the main data source. In addition, internal documentation was used as a secondary data sources for triangulation of the data.

The company has two kinds of IIoT solution offerings: Reliability and Performance solutions. This research studies if there is a difference between these two offerings and if the company needs two or more business models instead of one. Therefore, the interviewees' opinions were asked separately about both Reliability and Performance offerings. Thus, the differences and similarities between these solutions could be studied.

The initial Business Model Canvas was created based on interviews and documentation. Osterwalder et al (2010) guiding questions were used as an interview frame. The guiding questions are presented in Table 8.

Table 8 Guiding questions of the Business Model Canvas.

Component	Questions
Key Partners	Who are company's key partners and key suppliers? What resources are we acquiring from partners? Which key activities the partners do?
Key Activities	What activities do company's value proposition require? What activities do company's distribution channels, customer relationships or revenue streams require?
Key Resources	What resources do company's value proposition, distribution channels, customer relationships or revenue streams require?

Value Propositions	What value do the company deliver to the customer? Which one of customer's problems are the company helping to solve? Which customer need are the company satisfying? What bundles of products and services are the company offering to each Customer Segment?
Customer Relationships	What types of relationships do customers expect the company to establish and maintain with them? Which ones have the company established? How costly they are?
Channels	Through which channels do customers want to be reached? How ado the company reach them now? What about Channels integrated?
Customer Segments	For whom are the company creating value? Who are company's most important customers?
Cost Structure	What are the most important costs inherent in the company's business model? Which resources or activities are most expensive?
Revenue Streams	For what value are the customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each revenue stream contribute to overall revenue?

According to Osterwalder et al (2010) a competitive business model can work today but be outdated tomorrow. The company must all the time investigate how they can improve their business model. Thus, the interviews were not only focusing on finding company's current business models but also tried to resolve what is company's desired business models. The interviewees were asked both the current and the desired state of business model components. The interview template with guiding questions can be found in Appendix A. The guiding questions were asked if the discussion about the themes did not advanced.

In this research, first were interviewed the directors of the Industrial Internet department to get the overall picture and vision of the business. The interviews continued with snowball sampling to middle management and project owners. In this research business models were studied through two IIoT solution projects and thus, the project owners were chosen as interviewees because they have an overall picture of the project. In addition, people in the other departments were interviewed to get picture of how other departments supports the Industrial Internet department and how do they see the IIoT. The interviewees and the subject of the interviews are presented in Table 9.

Table 9 Interviewees.

Code	Position	Subject	Number of interviews
D1	Director	Overall picture and vision of the company's industrial internet	1
PM1	Project Manager	Business model of solution project	1
PM2	Project Manager	Business model of a company's services	1
M1	Manager	Business model of Performance solutions	2

M2	Manager	Business model of Reliability solutions	1
PM3	Project Manager	Business model of solution project	1
D2	Director	Overall picture and vision of the company's industrial internet	1
M3	Manager	Customer segment of the company	1
M4	Manager	Customer segment of the company	1
E1	Engineer	Business model of solution project	1
E2	Engineer	Business model of solution project	1
D3	Director	Business model of solution project	1
D4	Director	Business model of a company's services	1
Total			**14**

The interviews were conducted in Finland and Sweden and the language of the interviews was either Finnish or English depending on the interviewee. The interviews were conducted between March and April in 2018. Duration of the interviews were from 30 to 60 minutes. The interviews were conducted either face-to-face or via Skype. The notes were written on a word document using interview template (see Appendix A).

After the interviews, the initial Business Model Canvas was created and presented to the interviewees. The initial Business Model Canvas was iterated based on the opinions of the interviewees and reflected on theory. At last, the final Business Model Canvas was created based on the analysis and findings of the interviews.

6.2 Business model of the company

The case company has recently created new Industrial Internet business line. The business line utilizes company's other business lines' business models in some level but they don't have clear picture of what kind of business model they should use. In other words, the company is already doing some business with the IIoT solutions but they don't have a uniform business model.

The company is creating IIoT solutions which are either IIoT applications, IIoT services or their combinations. Individual IIoT solutions are addressed to specific machine. The overall IIoT solution is addressed to a system which contains several different machines. The IIoT solutions are delivered to the customer through an online portal.

The company has two types of the IIoT solutions: reliability and performance. In addition, the company offers services to these applications. Both types of solutions should have their own uniform value propositions and revenue models but individual application's value proposition should always be unique. The empirical research revealed that the fi-

nance, infrastructure and customer components are the same for both solutions. The differences between the solutions are in value proposition component. The business model canvas of the company is presented in Table 10 as whole.

Table 10 Business model canvas of the company.

Components		
Key Partners	*Platform Developers* *Platform Providers* *Analytics Device Manufacturers*	*Customers* *Customer's other suppliers* *Ecosystem partners*
Key Activities	*Platform Development* *Product Development* *Data Collection* *Data Analytics* *Data Modelling*	*Remote expert service* *Marketing* *Customer Integration* *Solution delivery*
Key Resources	*Platform* *In-house know-how and algorithms* *Data* *Sales Capability* *Solution Delivery Capability and Mindset*	*Employees* *Supply Chain Network* *Financial Resources* *Business & IT Integration*
Value Proposition	Performance • *Efficiency* • *Cost savings* • *Environmental issue* • *Simplification* • *Minimizing quality deviation* Reliability • *Advanced condition monitoring* • *Preventing failures* • *Improved services*	Service • *On-demand remote support* • *Remote monitoring* • *Analysis services* General • *Improved training* • *Modern user interfaces* • *Information security* • *Brand*
Customer Segments	*Segmented markets* *Small volume*	*Business to Business*
Channels	*Face-to-Face*	*Online Portal*
Customer Relationships	*Co-Creation* *Collaboration tools* *Personal assistance*	*Self-service* *Predictive marketing*
Cost Structure	*R&D cost* *Hardware cost* *Marketing and sales cost* *IT cost*	*Personnel cost* *General and administrative expenses* *Customer relationship cost*

Revenue Streams	*Asset bundle* *Subscription* *Gain sharing*	*Investment fee* *Freemium* *Usage fee*

In the next nine subchapters, each of the business model components are analyzed.

6.2.1 Key Partners

The company has a long history in a traditional manufacturing and it does not own a large IT development department. Recently the company have started to acquire IT developers, due to desire for developing IIoT solutions. However, the goal is not to achieve completely independent development department.

D2*: "We need our own core team but otherwise the development should be outsourced. Certain employees from partners become part of the development team with long term cooperation agreement"*

The company is creating long-term IT development partnerships where partner's employees are engaged to the company's development department. The basic development is done in-house but for example analytics and data-science the development is outsourced.

DI: *"For now, we only have a few analytics development partners but the desire is to increase their amount. For example, predictive analytics and process analytics provider companies are needed as partners."*

The company is using a third-party cloud platform as a base structure for its IIoT solutions. The cloud platform is essential part of the company's business and thus a close partnership with platform providers is needed. However, also the platform itself needs a development activities. The platform development is outsourced to a long-term partner company.

One group of key partners are edge device manufacturers. Edge devices are sensors and actuators which operates between physical world and the platform layer. They allow the system to sense and manipulate its environment. (Gilchrist 2016)

D1: *"We need partners who manufactures IIoT devices and have knowledge of these IIoT devices in order to be able to offer IIoT solutions."*

In addition, the company is trying to create partnerships with the customer's factory's another systems manufacturer.

D1: "*If we gain more knowledge of these customers' other systems we can more accurately predict whole factories' operations."*

The company's vision is to optimize customer's whole factory and thus it is essential that the company has good knowledge of all the edge devices and not only their own devices. If the company knows what is happening in the beginning of the production line it can more accurately optimize its own machines at the end of the production line.

The IIoT is a data-intensive activity and thus the company needs to gain customers' trust in order to get access to their data. The company sees its customers as key partners. However, the company has identified that it particularly needs a few pilot customers as key partners.

D3: *"It is vital that we understand our customers as good as possible in order to meet their needs."*

M2: *"The partnership with these pilot customers must be particularly effective so we have to get feedback from the customer so we can develop our solution."*

With these pilot customers, the company can develop new IIoT solutions which meets the needs of the customers. However, the company cannot maintain such close communication with every customer. Thus, it has to create partnerships with customers who can tolerate some risk of piloting and who can communicate effectively.

The company's vision is to create ecosystem which involves all the partners presented above. All the partners should operate transparently.

D1: *"The desire is to create an ecosystem in which the value for the customer is created as a cooperation of every party in the value chain."*

With ecosystem, the company and ecosystem partners can offer more value for its customers. Moreover, every actor in the ecosystem should gain some added value so it would be a valuable addition to the ecosystem.

6.2.2 Key Activities

The company has used to develop physical products but the IIoT solution development differs from this quite a lot. The company can and try to develop IIoT solutions using Minimum Viable Product (MVP) method.

D1: *"We are developing IIoT solutions using the MVP method and DevOps model in order to be agile and to meet the customers' needs. This is however new to us because our traditional products are huge systems which have to be completely finished products when introduced to the customer."*

In the MVP method, the product is released in early a phase as possible to demonstrate the value of the product for the customer. This way the product can be design in a way customer prefers. (Moogk 2012) The product is designed with minimal features to satisfy the customer. This way, the company can introduce the solution for the customer quickly and the company has an opportunity to develop the solution based on customer needs.

The product development of the company has advanced in other areas also. The company has introduced a DevOps model. DevOps integrates development, delivery and operations instead of performing them in separately silos. In DevOps model, cross-functional teams work together in order to deliver better value faster for the customer. (Ebert et al. 2016)

In addition to individual IIoT application development the company needs to develop its platform, where the applications are run.

D1: *"We need to develop our computing platform which operates behind every individual IIoT solutions. Essential part of application and platform development are data activities such as data collection, data analytics and data modelling."*

The company has to build these data activities in the platform. Moreover, applications might need individual customization of the platform. The company needs to have the technology to acquire the data but in addition it needs attractive value proposition in order the gain access to customer's data.

The company aren't selling only stand-alone IIoT applications but IIoT solutions where the application and service are bundled. Thus, service activities are also a major key activity of the company.

PM2*: "We offer remote expert services for our customers. Our professionals help the customers when application notifies from some error."*

The company's personnel needs expertise of the field and application but also customer service skills. However, it is hard to compound all these skills. Thus, there is no single person who would master all these skills but the company guides the customer to right person.

The company has pilot customers with whom the company co-develops the solutions. Co-development needs effective communication between the company and customer.

D1: *"We need partner management activities to manage co-creation and outsourced activities with our many partners."*

The company has to be able to communicate effectively with all its key partners. With effectively communication, the company can maintain its partnerships and create added value for its customers. In addition, because the company is trying to create partnerships with the customer's factory's another systems manufacturer, the company needs the ability to integrate on customers' other systems. Moreover, the company needs to be able to communicate effectively with its customers. Marketing activities are needed to advertise and sell IIoT solutions.

D1: "*We have skilled marketing people but they are used to selling physical products. Similarly, the customers are used to buying physical products. However, the IIoT solutions are mainly intangible products and thus we must develop our marketing activities to answer these challenges. The goal is that we could sell our IIoT applications as a part of a bigger system."*

The change in the marketing activities is a challenge for manufacturing companies which are implementing IIoT solutions. Companies have to acquire new marketing people with required skills or retrain its current marketing people. Besides marketing, the company also needs to delivery abilities.

E1: *"Delivery of the IIoT solutions requires installation of software and hardware as well as education of the users."*

The delivery of IIoT solutions is a combination of product delivery and software delivery. Thus, the manufacturing company might have to learn to deliver software.

6.2.3 Key Resources

One reason for the company to enter the IIoT business was its resources.

D1: *"We have great knowledge of industry processes and our own machines."*

D2: *"Because of our in-house knowledge we have competitive advantage to offer services for problem solving."*

The company has a great knowledge of industry operations and processes. Moreover, it has long history in building products to the industry and it has already developed on-premises software algorithms for these products. The purpose of current development is to bring all this information into a one place and create value out of it as a wholeness.

Another company's key resource is its cloud platform.

D1: *"One key resource for us is our cloud platform. Cloud platform does all the data activities needed in IIoT-driven business such as data collection, data processing, data analyzing, data visualization processes and the ability to utilize the data on operations."*

Cloud platform is an essential part of IIoT-driven business model and it enables the whole IIoT-driven business. The platform operates behind the IIoT application. As Thoben et al. (2017) argue that the idea of the IIoT is to connect industrial assets together. The cloud platform is a way to do this. It collects and processes the data created on the edge tier and offers processed data to user or application. Furthermore, the data or access to the data is a key resource for the company.

M3: *"We have competitive advantage because we have a large customer base from which we can gain data."*

D2: *"We have created trustful connection to our customers which helps us to sell our new IIoT solutions."*

The company have operated with customers a long time and they already have trustful relationship with customers. Thus, it is easier for the company to get access to customers' data. Moreover, the company already has lots of customers from whom they can acquire data. Besides that, it is easier to sell IIoT solutions when the company has trustful relationship with the customer. To conclude, the sales and solution delivery capabilities are key resources of the company as well.

Employees are a clear key resource of the company.

D2: *"Currently we have skilled employees on process know-how but we lack employees with analytical and data-science skills."*

D1: *"We need people who understand technologies but also people who understand the logic of creating digital offerings. Employees should have certain mindset."*

The employees are needed not only to develop applications but to develop business cases and marketing IIoT solutions. It is challenging task for the company to change the mindset of the employees, which are accustomed to build and sell physical products. The company

has identified that the software development should be centralized to digital hubs. This way the quality of the applications stays similar.

The company has done strategic choice that is outsources some of its IIoT development. This increase the importance of partners. The company identifies its supply chain network as one of its key resources. Other key resources, the company has identified are its financial resources and business and IT integration.

6.2.4 Value propositions

The company divides its IIoT applications to reliability and performance applications. Both of these applications have different value propositions. In addition, the company has general value propositions for its applications and services.

D2: *"Our goal of the IIoT solutions is to offer data-based optimization, diagnose the usage of the machine and advise the user to operate the machine.*

In the other words, the company increases customers' performance by optimizing, increasing reliability with diagnostics and simplifies customers' processes by advising the user of machine. The data-based optimization is offered through performance applications.

M1: *"The value propositions of the performance applications are efficiency, cost savings, environmental issues, simplification and minimizing quality deviation."*

Efficiency makes it possible to produce more and better-quality end products using less resources.

M1: *"The goal is to optimize the ratio between customer's quality and costs. Cost savings and environmental issues are the result of the improved efficiency. Environmental issues include energy savings, decreased pollutions and resources. Simplification is offered by reducing the need of human interaction in the processes and allowing the operations to be done remotely. Minimizing quality deviation is important because it is important for the customer that the end products are as homogeneous as possible."*

The data-based optimization offers several value propositions. However, the company doesn't just try to decrease cost or improve efficiency but tries to balance between quality and efficiency. Decreasing the human interaction naturally decreases personnel expenses but also decreases quality deviation. The diagnosis of the machine usage is offered through reliability applications.

M2: *"Unexpected breakdowns of the customer's systems are extremely expensive. Thus, the goal of the reliability applications is to prevent unexpected breakdowns and minimize the duration and number of the scheduled breakdowns. The value propositions of the reliability applications are advanced condition monitoring, preventing failures and improved services. With advanced condition monitoring the machine can be monitored in real-time and the lifetime of the spare parts can be predicted. This enables preventing the failures but also the improving services. The company sees the condition of the customer's system and can predict when some spare part must be changed. Thus, the company can deliver the spare parts just in time and reduce customer's operation capital."*

The breakdowns are expensive for the customer and customers tries to minimize these. Customer's factories are all around the world and the delivery of spare parts can take a long time. With the IIoT solutions the company can predict when specifc parts are about to break down and can deliver new parts just in time. This is highly valuable for the customer.

The advices to the user on how to operate the machine is a general value proposition for both applications.

D2: *"The idea is that if performance or reliability can be improved somehow the application will guide the user how to act. The application helps the user to operate the machine as well as possible. The customer wants to operate the system itself but they are willing to take advices about how to operate it better. Moreover, training a new employee requires less effort for the customer since the applications guide the new employees."*

With these advises the customer can increase its performance and reliability. Moreover, the customer training expenses decrease as the IIoT solutions become easier to use. However, the IIoT solutions are not only autonomous applications but they include services as well. The company's IIoT service enables the reliability and performance applications but they also have other value propositions.

D2: *"Due to the IIoT, we can offer on-demand remote support, remote monitoring and analysis services."*

With on-demand remote support the company's professionals can remotely solve customers' problem faster and cheaper. The company can also monitor customers' systems remotely and offer guidance if they notice issues. Analysis services allow the company to solve customers' problems in co-operation with the customer. The goal is to increase the quality of service.

Other general value propositions are modern user interfaces, information security and brand. However, alone these value propositions are not enough.

PM3: *"New user interface monitors alone are not enough for the value proposition"*

D1: *"I wonder, are the modern user interfaces new 'de facto' in the industry and no longer differentiating the value proposition?"*

D1: *"Customers value our brand but some are afraid that our influence grows too much while we are expanding to the IIoT solutions"*

However, modern user interfaces, information security and brand as value propositions aren't enough. They are more likely seen as "nice-to-have" features except for the information security. The information security has risen as a central concern among the customers. The company must ensure the information security of its IIoT systems and advertise the information security as a value proposition. Finally, the company has noticed that the price is not the most important value proposition.

D1: *"The price is the most important value proposition only for a very few customers and we do not try to be a cost leader."*

The customers value other things more than just prices. After all the price of the IIoT solutions are rather small compared to customer's other business.

6.2.5 Customer segments

The company's customer segments guide the company's business quite a lot. The company operates on Business-to-Business field in which the customers are always organizations and their purchasing processes are complex.

D1: *"The user of the product and buyer of the product are not the same. Furthermore, individuals can't do the purchase decision alone and the customer needs for example a business case, payback period and management's approval to buy."*

The company must define its value proposition in a way that it is useful for the user and profitable for the buyer. Both user and buyer must understand the value of the solution. Moreover, the company must evidence the value of the IIoT solution for the customer explicitly.

M2: *"The customers vary a lot among themselves. For example, large customers rather pay products at once because the installment payments cause labor costs for the customer. In turn, small companies rather use subscription to pay so they have time to earn the money before the payment."*

The company must acknowledge that it may expel some customers if it engages too strictly to a single business model. The company must be able to serve both its small and big customers. In addition to the size of organization, the opinions of management affect the business model as well. The opinions of management affect what things they value and how much they are willing to pay it. Currently the company sells products to individual factories and not for the corporations that owns the factories. Thus, the opinions of individual managers are emphasized.

M2: *"The amount of resistance to change differs between customers a lot."*

D1: *"In the industry, the amount of the customers is low but individual customers buys a lot."*

The company can sell different products, services and applications for a one customer. But naturally one customer buys one application only once and thus, the amount of individual applications which can be sold is rather low even though in total the company can sell plenty applications. Furthermore, the volume depends on the application.

The company has been selling products and services for a long time and it has strong customer base. Currently the company is selling new IIoT solutions to its old customer segments.

D1: *"For now, we are focusing on our current customers and we are not going to expand our customer segment."*

However, they have identified that it would be possible to expand the customer segments to multi-sided customer segments by selling the collected data to third parties. Currently, the company have segmented markets. The company is selling various products to a few

specific industries. The company is selling overall systems which are customized for every customer.

M2: *"There are no two customers with identical systems. Thus, the IIoT solutions must be customized also. However, the individual applications can be generalized."*

In other words, the company's IIoT solutions must be modularizable. The customer buys different machines and the IIoT applications are designed to these machines. Thus, the company can build IIoT solution from the applications which are designed for the machines the customer has.

6.2.6 Channels

The customer segment guides the choice of the distribution channels. As described earlier, the company operates in business-to-business environment where the buyer is not individual but an organization which involves many people. Furthermore, the user and the buyer of the IIoT solution are not the same. Secondly, the number of customers is rather low although their purchasing power is high. Therefore, the amount of individual IIoT applications the company can sell is low. Currently, all the company's sales and marketing activities are done through face-to-face.

D2: *"Most of the applications are related to the creation of an overall solution so it requires face-to-face sales."*

PM3: *"Do we even need anything else but face-to-face sales because the number of customers are small."*

PM1: *"So far, we are selling the IIoT applications as a part of overall IIoT solution. Currently the application delivery needs rather a lot of customization"*

Because customer's systems vary, the IIoT solutions must be customized for every customer. The delivery of the applications can even be compared to project delivery. However, the company has identified that they have to create clear offer categories which they are selling.

Although the company is selling its IIoT solutions face-to-face, it has identified the possibility to advertise its new IIoT applications through an online portal. The idea is to increase the customer's knowledge about the new IIoT applications. Teasers of the new applications would be presented in the online portal.

E1: *"Currently the customers use IIoT applications through online portal. All the company's customers use this online portal although the customer isn't using any IIoT applications."*

E1: *"There are two possible ways to advertise these applications. The company can either grant the customer an access for the app for a certain period or the company can show some data of the application on the online portal but the customer won't have access to whole application."*

The question if the applications should be sold online, shares opinions. Some interviewees think that the company's IIoT applications can be sold online if the application is simple

enough and easily defined. Others thinks that online sale is unlikely because customer's buying process is always rather complex. Moreover, IIoT applications are usually connected some service agreement which needs interaction face-to-face.

6.2.7 Customer relationships

The customer segments guide the nature of customer relationships. The company's customer relationship is multifaceted and involves a lot of people.

D2: *"The goal of the company is to deliver integrated multi-channel customer experience using digital solutions and services."*

The interviewee refers that customer experience should be integrated not only between IIoT solutions but also between different business departments. The company has clear vision that in the future the customer relationships are maintained through digital solutions. Naturally services also need human interaction. One way to maintain customer experience is co-creation. The company has identified the need of co-creation in order to be able to develop products the customers need.

M2: *"It's foolish to believe that we could guess customers' needs. Co-Creation is the only way to create added value for the customer."*

Especially, in B2B context where number of customers is small. It is important that the company develops products the customer is willing to buy. Moreover, the companies are more price conscious than consumers. Nevertheless, the co-creation is challenging for the company due to several reasons.

D1: *"When big companies co-create products the intellectual property right (IPR) becomes a key issue. The intellectual property rights raise many questions such as what rights the customer has for the products, how the company can monetize the product and can the company sell the product to customer's competitors."*

It is understandable that companies are cautious about intellectual property rights, since they have to bind resources in co-creation while the competitor gets the result without the same effort. The another, challenge in co-creation is that customer don't know their needs or the needs are not realistic.

M1: *"The customer's might not know what they want or the customer's needs might not always be profitable to implement. Furthermore, the solutions might not be generalizable."*

It is important that the solutions are generalizable because the goal of the company is not to be an IT-project company but an IIoT application and solution provider. Currently the company uses carefully selected pilot customers for a co-creation partners.

M2: *"The customer must be open minded to test new techniques and be ready to tolerate some risk. The communication with the pilot customer must be active and effective. The pilot customer must be able to give valuable feedback. The revenue model for the pilot customer must be different than for other customers and all the expenses cannot be charged."*

There is always a risk in co-creation that the end product is not valuable. Both parties may have used a lot of resources without any results. It is safer for the company to buy a finished product which certainly works. However, the customer can gain competitive advantage out of co-creation when they are the first ones implementing the new technology.

It is natural that the co-creation needs effective communication. The co-creation develops new products in co-operation with the customer and the company. However, it is not pleasing the customer. (Prahalad & Ramaswamy 2004) In co-creation both parties must participate in developing and continuously giving feedback to each other. It is understandable that when the customer has to bind resources on the development the company cannot charge everything from the customer.

The company has started to create social media for its customers. The company sees the social media as a tool between the company and individual customer. However, it is not realistic that there would be online community for the customers where customers can communicate to each other.

D1: *"I don't see that there would ever be an online community where the customers would communicate with each other because the customers are competitors among themselves. Secondly the individual customer is an organization where the communicating person changes frequently."*

It is unlikely that competitor organizations would start to communicate with each other online. The in-house knowledge is a competitive advantage for the organizations and they don't want to share it to others. Moreover, it is an information security risk to allow employees of a competitor organizations to chat with each other. It is not realistic to train every employee what they can and cannot share within these online communities where the competitors operate as well. However, the company is creating collaboration tools for customers to discuss with a company's professional.

PM2: *"With collaboration tools, the customer can discuss with the company's professionals and ask solutions for problems on using the system. Also, the company's service people can contact to the customer through this portal if they notice that there is something wrong with the customer's system. The goal is that the customer can operate on its own but get on-demand personal assistance if needed."*

The collaboration tools are a channel to serve the customer. The company can deliver its services through these tools. However, although the company is serving personal assistance through collaboration tools it tries to offer self-service tools as well.

D2: *"Our vision is that the machines could automatically order spare parts or the application could inform the user what to do if there is an issue. For now, the customer gets the information from the application that there is an issue and the customer can contact the company if it can't solve it alone."*

The company's vision is to create more autonomous applications which would decrease the need of personnel. However, for now the services operate as an extension of the application and fulfill the value proposition for the customer. Furthermore, the IIoT allows the company to offer predictive marketing and more customize offerings.

M2: *"With the help of the IIoT we can see in real-time how the customer acts and operates. Furthermore, we know the state of the system and can predict the need of spare parts and maintenance. This allows us to customize our products to answer the customers' needs. Moreover, this allows the company to do predictive marketing. We can offer the customer products and services which it more likely needs soon."*

The benefit of the IIoT is that it allows the company to create more personalized offerings which fulfill the customers' needs better. Moreover, a new aspect that was not presented in the literature is that the company can offer predicative marketing and for example offer maintenance service before the customer even realizes it needs maintenance.

6.2.8 Cost structure

Company's cost structure is formed from the key resources, activities and partnerships and it is essential to identify these before one can estimate the cost structure. All the interviewees were uniform that the company's biggest cost item for now is R&D cost. R&D cost includes both application and platform development cost. However, the R&D cost decreases as the company IIoT solutions mature.

D1: *"In the future one big cost item will be platform usage fee when the amount of applications increases."*

D1: *"Other cost items are hardware cost, marketing and sales cost, IT cost, personnel cost, general and administrative expenses and customer relationship cost."*

Although the IIoT applications are sold for the systems which enables IoT solutions, usually some hardware installations must be done. IT cost includes platform licenses and maintaining the IT infrastructure. Personnel cost consists of installation, development, maintenance, marketing, application disposal, customer training and other services activities. Platform costs are allocated for the applications. Application's cost structure is presented in the Figure 12.

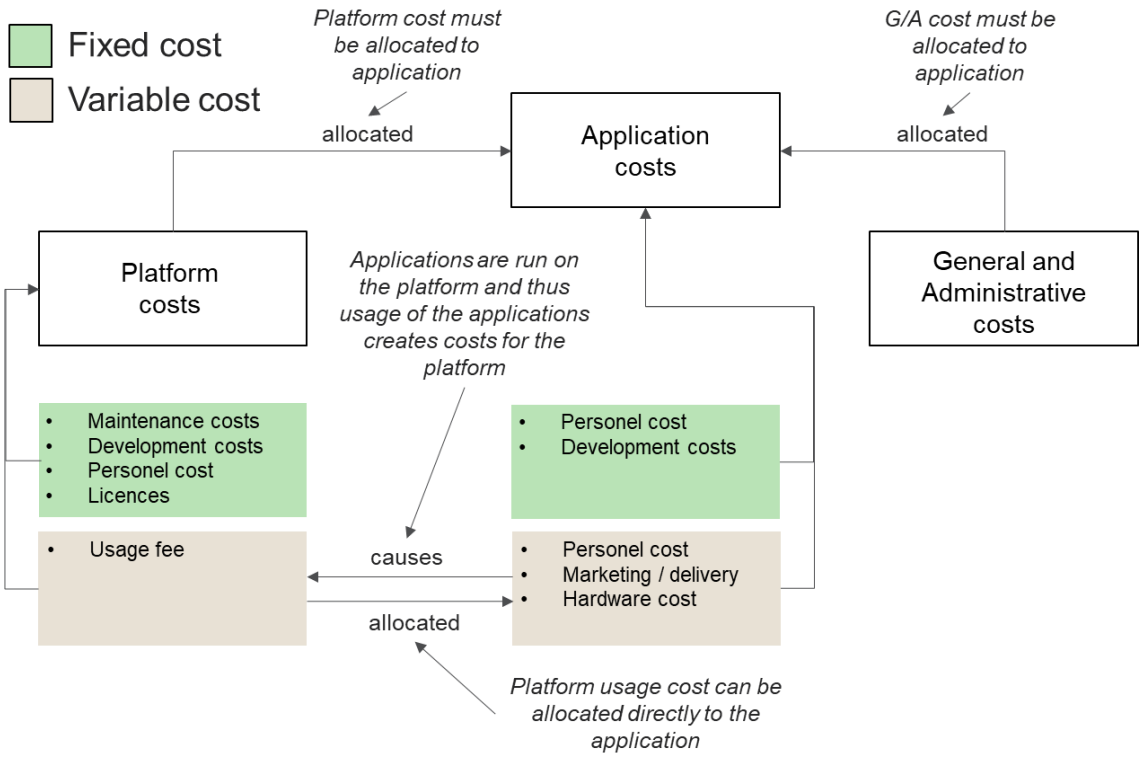

Figure 12 IIoT application's cost structure.

D1: *"Applications are run on the platform and the thus usage of the applications creates costs for the platform. Platform costs are generated based on usage and these costs can be allocated straightly to the application."*

The cost items are different depending of the phase of the solution. The product life cycle cost of the IIoT solutions consists of development costs, delivery costs, operating costs, maintenance costs, disposal costs and general and administrative cost. The product life cycle cost is presented in Figure 13.

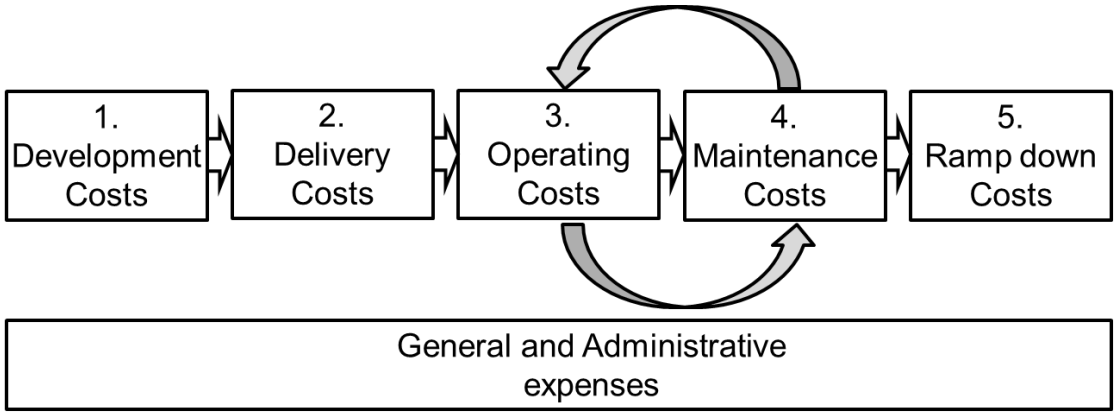

Figure 13 Product life cycle cost.

Development costs are a fixed cost which occurs when a new application is developed. Delivery costs are a variable cost which occurs every time the application is sold. Operating and maintenance costs are a variable cost which occurs while the application is running. Maintenance costs can be fixed or variable and occurred either occasionally or

constantly. Disposal costs occurs when the usage of applications ends. Disposal cost may occur due to the individual customer end the usage of the application or the company ends the maintenance of the application. Disposal costs can be fixed or variable.

6.2.9 Revenue models

The company is currently using several different revenue models without uniform practices. However, the company has identified the need of uniform practices on revenue models. The company is aware that there isn't a single revenue model which would be applicable for every situation and every application. Currently, the company has its own revenue models for its machines, services and on-premises software. The company uses an asset bundle for its new machines.

M2: *"We have been selling services bundled with the machine for a warranty period. After the warranty period, the service is charged for example based on a subscription model. A few IIoT solutions have been sold using this model as well."*

In this model, the price of the service is embedded to the price of the new machine. When the customer has already gotten used to the service they probably will subscribe to it after the warranty period ends. In the service business, there have been two different revenue models: the subscription model and the gain sharing model.

D4: *"Gain sharing model has been used on service which improve performance."*

The gain sharing model can be used when the company knows that the service will improve customer's performance. The performance must be able to measure as explicitly as possible.

M1: *"The idea of the pure gain sharing model is that there is some fixed subscription price and on top of that there is performance -based price. If the company achieve some predefined performance level, the fixed subscription and performance based price together are the same as the price in traditional subscription model. If the performance is lower the customer might pay only the fixed price. If the performance is higher the customer pays more than what he/she would pay while using traditional subscription model."*

The predefined level must be agreed as cooperation with the customer so both parties can engage the agreement. The Gain sharing model is presented in Figure 14.

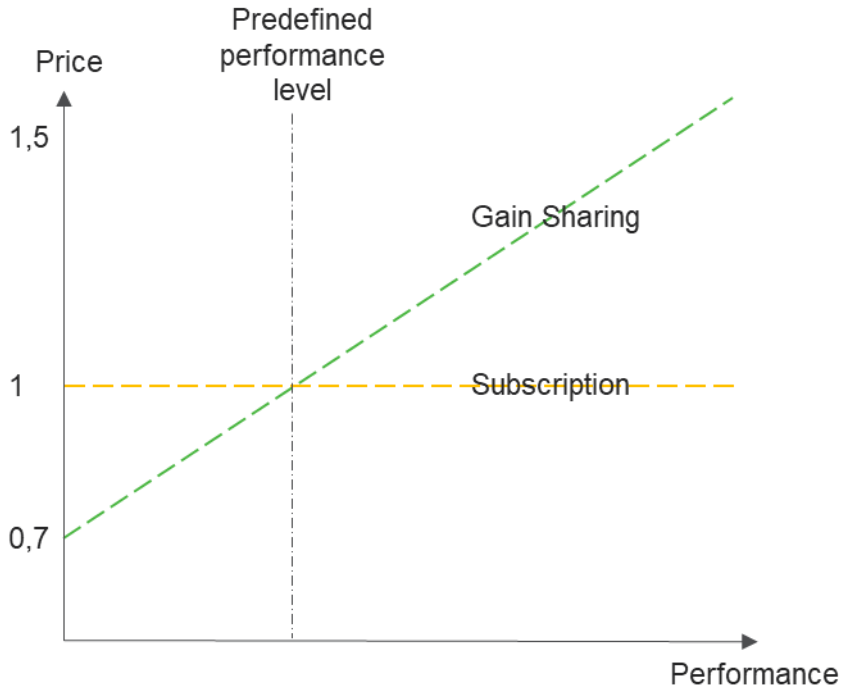

Figure 14 Gain sharing model.

There is a possibility to earn more money out of the gain sharing model but there are challenges on using the pure gain sharing model.

M2: *"Pure gain sharing model includes high risk and thus the price must be higher than in a traditional subscription model. Hence, there must be an assurance that the solution works and achieves or even exceeds the performance level. This of course requires a lot of work in advance which is also expensive."*

Considering the risk, the company should assign the predefined performance level lower than the actual performance level they can certainly achieve. In this way, the company should earn more money from a gain sharing model than subscription model even if both models would achieve same performance level. The risk of a pure gain sharing model can be reduced using a mere bonus model.

M2: *"Gain sharing model can also be a mere bonus model where a customer pays for the whole subscription model anyway but additional revenues are shared between the company and customer."*

In a mere bonus model, it is assured that the solution is profitable for the company. The possibility for increased performance is usually attractive for the customer as well. However, the pure gain sharing model is more attractive for the customer. However, in both gain sharing models there is a risk end up to fighting with the customer.

M2: *"There is a risk to end up disagreeing with the customer which is a highly unwanted situation. The disagree could be a result of the interpretation of the performance results. The customer might claim that the performance improvement is not the result of specific IIoT solutions but customer's own actions."*

The disagree with the customer can be extremely expensive for the company. The company can lose the customer and at worst suffer brand losses which might lead to loss of several customers. “The customer is always right” is an old slogan but it can still be applied to these situations.

Subscription model is quite straightforward. The customer pays on a monthly or an annual basis, to get access to the application. The subscription might include service or it might include only the maintenance of the application. However, all the applications can’t be offered without the service.

PM1: *“The application must be matured enough if there isn’t any service included in the subscription.”*

The application must be easy to use and it must fulfill its value proposition without human interaction. The company can offer a part of the value proposition as a service. Nevertheless, there is a risk in subscription model as well.

D1: *“In subscription model the application makes losses at the beginning. The customer should be locked in the subscription until at least a break-even point is reached. One way to lower the break-even point is to add an investment fee on the application. The investment fee can be used when the application needs a lot of personalization or hardware investment on the customer’s premises.”*

The company must knowledge how long it takes to achieve break-even point and consider how to tie the customer to that time. The customer can be tied for example with warranty period. Other way is to try to lower the break-even point.

Apart from the machines and services, the company has been selling on-premises software using licensing model and bundling it with service for a warranty period.

D2: *“After the warranty period, the customer can terminate the service agreement but the software remains with the customer. In this case, the customer won’t pay anything anymore. However, there are certain terms of conditions for the customer such as the software should not be copied and there isn’t maintenance.”*

Usually the customers continue using the service after the warranty period but not always. However, the price of software is calculated in a way that it has already paid itself off when the warranty period ends. Licensing model is used due to customers’ resistance to change.

M1: *“Customers are afraid that after the agreement they have nothing. Markets are not ready for a pure SaaS* (Software-as-a-Service) *model”*

The people who make the buying decisions are rather old and are used to buying physical products. Thus, it might be difficult for them to validate profitable of subscription model. Moreover, as we noted earlier, the company’s marketing people have neither been accustomed to sell digital solutions. Nevertheless, the company has identified that the license model cannot be applied to IIoT applications, at least as such.

D1: *“IIoT applications are provided through cloud which causes operating costs for the company continually. These costs must be allocated to the customer somehow.”*

It is hard to allocate a continuous cost to a licensed application. On the contrary some IIoT applications can generate indirect revenues for the company.

D2: *"The customer probably uses company's maintenance service for its machines because the application recommends it."*

However, it is hard to define if the certain application generates service business. Moreover, it is hard to the predict how much the cost the application will cause in the future is. The company has a need for a model that could compound the benefits of the subscription and licensing model. For this, the company has also identified the possibility of using the freemium model.

M3: *"We can offer a loss-leader application for our customers either for free or for a minor fee. The idea is that the loss-leader application ensures the connectivity and improves the company's visibility within the customers."*

The loss-leader application ensures that the company gains data from the customers, which in turn enable the company to offer better solutions for its premium customers. For example, the company can offer gain sharing revenue model because it has better understanding on how customers' processes work. The profit is done with the premium applications.

M3: *"However, the loss-leader application must be attractive enough, so the customer acquires it but not too good that the premium applications stays attractive. For example, monitoring dashboard or modern user interfaces could be suitable loss-leader application. For the performance applications, there is a possibility to offer the application for free without the performance guarantee but agree to share the cost savings."*

The freemium model works if it attracts lots of customers and a large enough portion of them buys the premium model. Thus, it is essential to define value propositions right. However, the freemium model includes challenges as well. The loss-leader application causes operational cost as any other application. The company must knowledge this fact when implementing freemium model.

Finally, the company has identified that there is a possibility to use usage fee as a revenue model.

D2: *"Most applications are constantly computing regardless of whether the application is being used or not. However, the usage fee model can be used for some services."*

Using the usage fee for traditional application causes the same problem as the licensing model that application causes a continuous cost. However, the company will not use usage fee model for the time being.

6.3 Challenges of the business model

The interviews revealed many challenges the business environment causes for implementing such a business model. Many of these challenges are resulted from the customer segments. Due to the, customer segment the buying process is complex which results that an online sale is unlikely. Moreover, the size of the customer segments affects the amount

of individual applications which can be sold. The customers' resistance of change varies and in addition every customer's systems are different.

Co-Creation is challenging because understanding the customer's needs and value chain is hard. Also, due to the customer segments the co-creation usually raises IPR issues. Furthermore, there is a risk of using the gain sharing model because the company and a customer might end up disagreeing about the reasons of the increased performance. However, one of the biggest challenges for the company seems to be the access to the data.

D1: *"The customers don't want to share their data because they are worried about information security and especially confidentiality aspect. The customers are competitors among themselves and afraid that their data might end up to their competitor."*

It is not enough that the company ensures their information security, it must also prove to the customer that the information security is ensured. This might be challenging task for the company. In contrast, there are also internal challenges the company must tackle. An example of internal challenges is siloed business.

PM3: *"Every business lines tries to maximize their own profit. For example, company's other business lines might think that the IIoT solutions cannibalize their business line's products. Thus, they don't actively market the IIoT solutions together with the machines."*

The company should be able to think outside of business department silos and create value for the customer as a one company. Other challenges the company faces are that the customers are building their own IIoT solutions. Due to this, the R&D costs are high and proving the value proposition is hard.

7. DISCUSSION

In this chapter, the findings of the empirical research are discussed, and they are reflected to the literature. The chapter presents found similarities and differences between the empirical research and literature. This chapter answers to the research question:

- *What kind of business model can support the IIoT software solutions business in a manufacturing company*?

In the first subchapter, the characteristics of a manufacturing company's IIoT business models are discussed. In the second subchapter, the development of the IIoT-driven business model is discussed.

7.1 Characteristics of a manufacturing company's IIoT business models

The empirical research was conducted using the Business Model Canvas in order to reveal case company's business model and to develop applicable business model for IIoT solution providers. With the aid of the empirical research the common characteristics that affect the business model of the IIoT solution provider have been found.

Finding 1: Customer segments affects the implementation of the IIoT

The results of the empirical research supported the results of the Arnold et al. (2016) that the implementation of the IIoT has little or no at all effect to the customer segments but that implementing the IIoT might create new markets (Arnold et al. 2016; Ju et al. 2016; Burmeister et al. 2016; Toor 2017; Arnold et al. 2017a). However, the empirical research rather indicated that the customer segments affects the implementation of the IIoT.

According to Burkitt (2014) especially the engager companies need strong customer relationships to succeed. The empirical research revealed that the case company has a strong customer relationship with its customers segments. In similar fashion, it is easy to understand that even though the company would expand to the multi-sided customer segments, it must ensure that it can maintain strong customer relationship with its current customer segments.

The case company has decided not to expand its customer segments although they have identified that there is a possibility to expand customer segments to multi-sided customer segments. Therefore, the current customer segments of the case company are at the center of the company's business model development. In customer-driven business models the customer segments guide the business model development and other components of the Business Model Canvas (Osterwalder & Pigneur 2010). Illustration of the customer-driven business model is presented in the Figure 15.

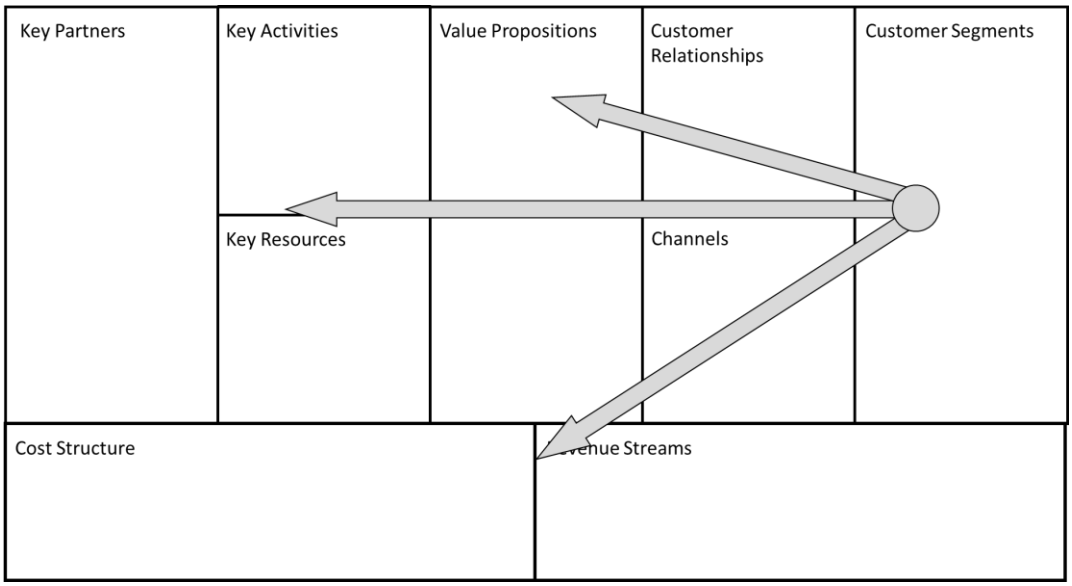

Figure 15 Customer-Driven business model.

Finally, the empirical research revealed that the company may expel some of its customers if it engages too strictly to a single business model. The company must be able to serve different customers differently. However, this issue was not studied in the literature.

Finding 2: Existing key resources might enable competitive advantage

The empirical research supported the results of the literature review about which infrastructure component characteristics are needed in IIoT-driven business. The characteristics are presented in Table 11.

Table 11 Key resources in literature and empirical research.

Literature	Empirical research
• *Physical Resources* • *Software* • *Financial Resources* • *Employees* • *Value Creation Networks* • *After sales service* • *Data* • *Platform* • *Integration level*	• *Solution Delivery Capability and Mindset* • *In-house know-how and algorithms* • *Financial Resources* • *Employees* • *Supply Chain Network* • *Sales Capability* • *Data* • *Platform* • *Business & IT Integration*

The results indicated that the engager companies need the right capabilities in order to succeed (Burkitt 2014). Engager companies are usually non-IT companies such as manufacturing company (Saarikko et al. 2017). However, implementing the IIoT requires lots of IT resources and activities. Thus, in order to cope with IT companies, the non-IT companies must have other resources and activities which gives the company a competitive advantage.

The empirical research revealed that the case company has a great knowledge of industry operations and processes. Moreover, the case company has a long history in building products in the industry and it has already developed on-premises software algorithms for these products. These key resources enable the company to enter the IIoT business without high IT-skills and to compete with the agile IT companies.

Finding 3: Cost structure, value propositions and customer segment affects the revenue streams

The empirical research revealed that unlike Arnold et al. (2016) have argued there are several components that affects the choice of the revenue model. Results of the empirical research are presented in Figure 16.

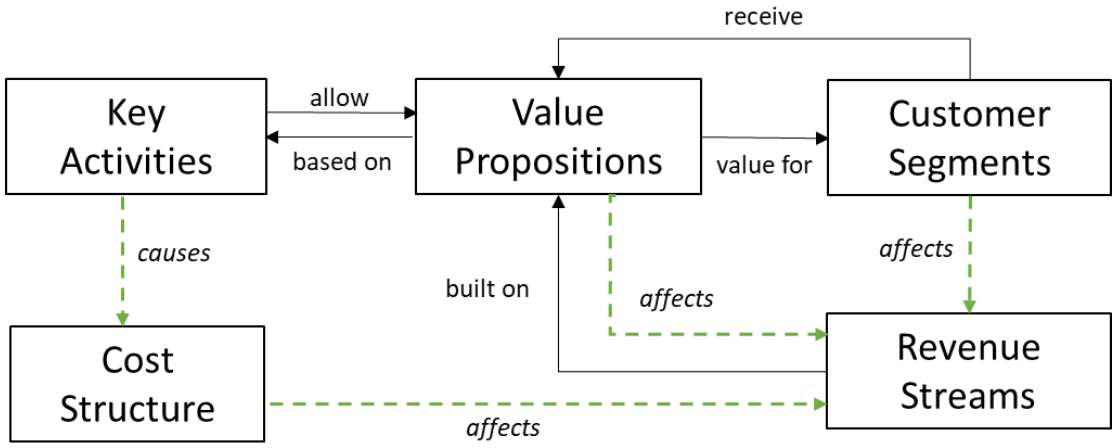

Figure 16 Components which affects the choice of the revenue model.

First component that affect the choice of the revenue model is customer segments. Engager companies require strong customer relationships to succeed (Burkitt 2014). At the same time, Arnold et al. (2017a) has remarked that the revenue models will hardly change due to customers' resistance to change. The customers are used to buying products using a certain revenue model and they don't want to change that. Moreover, the empirical research revealed that different customers favor different revenue models depending on their own business model. As we revealed earlier the company may expel some of its customers if it engages too strictly to a single business model. However, the results support also the idea of Schaefer et al. (2017) that subscription is most adopted revenue model.

The other component which affects the choice of the revenue model is the cost structure. The implementation of the IIoT increases IT costs which includes among other things maintenance of both software and platform (Engström & Skoglund 2017). The empirical research indicates that the IIoT causes operational cost continuously and the company must choose a revenue model depending on who is responsible for these operational costs. For example, cloud based applications create expenses on the platform constantly and thus these costs must be allocated to the customer who is using the application. Finally, Niyato et al. (2016) have argued that before determining revenue model the company must know its own cost structure.

Third component affecting the choice of the revenue model is the value proposition. The results of the empirical research indicate that the value proposition affects indirectly through cost structure because different solutions create operational costs in different ways. In addition, the results indicate that the value proposition affects directly to the choice of revenue model since some solutions are used occasionally while other solutions are used constantly. For example, Engström & Skoglund (2017) argue that charge for the uptime of a product as a revenue model will rise instead of traditional subscriptions. However, this model cannot be used if the product creates costs constantly even though the product is not used. Finally, in some solutions the performance of the service can be monitored and thus use the gain sharing model. In gain sharing model, the customer is charged based on the success of the service the company provide (Toor 2017). However, in all the value propositions the performance cannot be measured. Moreover, the empirical research revealed that gain sharing model includes higher risk than other models and thus it is not always applicable

Finding 4: Customer segments and value propositions affects to the distribution channel

Arnold et al. (2016) argue that implantation of the IIoT won't have a big impact on a company's distribution channels. The results of the empirical research supported partly the literature. The case company has identified that it still need consultative face-to-face marketing activities but it has also identified that there is possible to create online advertising.

The empirical research revealed that the customer segments and value propositions guides the choice of the distribution channel unlike Arnold et al. (2016) have argued. The company must choose its distribution channel in a way that it reaches its customer and can offer the customer relationship level the customer expected. The empirical research indicates that the company must identify what kind of customer segments it has and how they want to buy products and services. Results of the empirical research are presented in Figure 17.

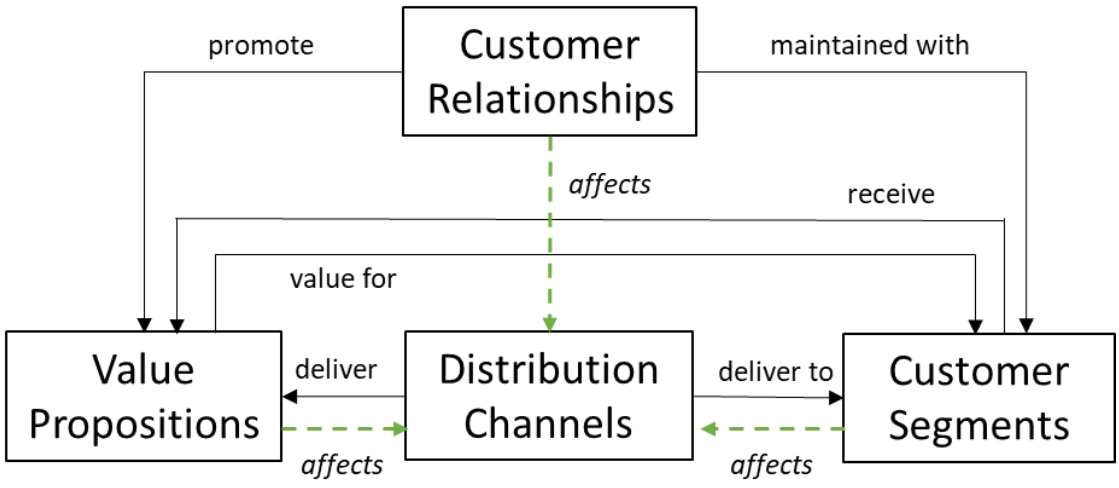

Figure 17 Components which affects the choice of the distribution channel.

Especially B2B customers have characteristics which might affect the choice of the distribution channel. The results of the empirical research revealed that the customer's buying process is complex in the manufacturing industry where the products are expensive.

Moreover, the IIoT itself is complex, which complicates the buying process (Klein et al. 2017). Due to a complex buying process and the several people involved in it, the company has to offer consultative sale. Similarly, Arnold et al. (2017a) have argued that the IIoT companies' customers need consulting. Furthermore, in case company's industry context the buyer and the user of the solution are not the same. Thus, the company must identify to whom they are selling their solutions. The marketing must be differentiated depending on to whom it is targeted in the customer's organization. For example, B2B customers need a business case, payback period and management's approval in order to buy.

The value propositions direct the choice of the distribution channel as well. The delivery process and need for the customization of the solution affect the choice of the distribution channel. Customization is one value proposition of the IIoT solutions and it enables modification of the products to meet the customer's needs (Ju et al. 2016). The more a solution needs customization the more it needs consultative sale. In turn, simple and easily defined solutions can be bought independently online.

The volume has an effect to the distribution channel as well. The empirical research revealed that the number of case company's customers is rather low and thus, the amount of individual IIoT applications the company can sell is low. When the volume is low the company must consider if it is profitable to invest and maintain certain distribution channels. For example, the case company already sells products face-to-face and it might not be profitable to create new distribution channels in addition to this.

Finding 5: Value propositions must be attractive enough

Like Arnold et al. (2017a) and Dijkman et al. (2015) revealed the amount of possible value propositions of the IIoT is almost infinite. The empirical research did not gain any new insight on this. However, the empirical research indicates that the information security is essential value proposition which must be assured in every IIoT solutions. The customers are worried about information security and especially confidentiality aspect. In addition, the data integrity has become an issue because companies are dependent on each other's security systems and vulnerability of one's system affects the other companies' systems as well (Engström & Skoglund 2017). Thus, customers might not want to share their data. Similarly, Klein et al. (2017) have argued that the privacy issue is essential part of the IIoT offering.

Arnold et al. (2016) argues that value propositions are the most affected business model component in the IIoT implementation. The company must have a clear value propositions which are based on customer's needs, profile and level of familiarity with the technology (Klein et al. 2017). Similarly, the empirical research indicated that the value proposition must be good enough that the customers are willing to:

a) share their data,
b) pay the price.

However, the empirical research implies that the low price alone is rarely the most important value proposition. Neither the literature review raises the price as a value proposition of the IIoT. Customer's cost reduction is however one value proposition of the IIoT solutions (Arnold et al. 2017a). Based on the empirical research the bigger issue seems to

be what revenue models are used. Different customers require varying revenue models, due to the nature of their own business models.

Finding 6: The company must ensure the connection to the customers' data

One of the biggest challenges for the company is to ensure an access to the customers' data. According to Littlefield (2016) the customer owns the data in every other case he has been studied. The company's IIoT solutions are based on collection and analyzing customers' data and providing processed information back to the customers. The company needs lots of data from different customers in order to be able provide IIoT solutions. However, customers are worried about the confidentiality of the data. Moreover, they are afraid that they lose their competitive advantage to for the case company and eventually to the competitors. The company must ensure the connection to the customers' data by providing an attractive enough value proposition.

It is natural, that the value proposition is more attractive if the price is lower. The company can use a freemium model to bind customers. In the freemium model, the basic solution is free and the customer pays for the premium-solution. The main purpose of the freemium business model is to attract new customers (Kumar 2014). Furthermore, the company can access to the customers data with freemium model.

However, there are lots of challenges with the freemium model. Because the basic solution is free, the company must be able to convert customers from a free version to the premium version. According to Kumar (2014) usually the conversion rate of the freemium products is 2 - 5%. Thus, the company must have a very low marginal cost for each new user so that the business model is profitable (Kumar 2014). The conversion rate might sound low but if the conversion rate is for example 50% there is probably a possibility to attract more users with better free version. On the other hand, while the amount of individual applications that can be sold is around 100, the 2-5% margin is far too small. Thus, the conversion rate must be at least 50% so one can think if the freemium is suitable for the industry.

It is challenging to define suitable value propositions for the free and premium versions. The value proposition for the free version is not enough if it won't attract new customers. However, if free version attracts customers but only few upgrades to the premium version then the value proposition for the free version is too good. Usually the right value propositions can be found only by testing. (Kumar 2014) However, the testing might be difficult in the industry where there are only a few customers. Customers may revolt when the company realizes that the value proposition is improper and tries to change it (Kumar 2014).

With the freemium model, it is also harder to maintain customers. According to Rietveld (2017) the service average lifetime subscription value for the customer is significantly lower in freemium model than charge-for-everything model. This is based on the sunk cost effect, where the customer will more likely invest additional money on the product or service if they have made prior investment. (Rietveld 2017) To maintain the customers the company must clearly communicate what the customer gains for upgrading to the premium version. (Kumar 2014)

The freemium model suite for the company if the value of the product is high and customers tend to underestimate the value significantly. Otherwise, the charge-for-everything model is better. (Chen et al. 2018) Moreover, if the company uses the freemium model it must create more value or operate at lower costs than its competitors. Many companies which use the freemium model offer advertisements in their products or services in order to compensate for the lost revenues (Rietveld 2017). However, the value of the data in the freemium models has not been taken into account in the literature.

Finding 7: Key partners are likely to change

The key partners are one of the most affected components of business models while implementing the IIoT (Arnold et al. 2016). However, the effect of the IIoT depends on earlier context of the company (Engström & Skoglund 2017). The empirical research revealed that the case company has a long history in a traditional manufacturing but it does not own a large IT development department. Thus, it needs to acquire IT developers. Recently the case company has started to hire IT developers, due to desire for developing IIoT solutions. Similarly, Klein et al. (2017) remarks that the need of new IT skills and analytics partners rises and company must recognize which capabilities should be developed in-house and what should be outsourced. The company must acquire new and retrain current employees. (Klein et al. 2017)

Literature review revealed that the customers have become key partners of the IIoT company. Customers are collaborative partners which are involved in developing the products. Co-design and open innovation processes are activities in which the customer participates to company's operations. (Arnold et al. 2016; Schaefer et al. 2017; Arnold et al. 2017a) The empirical research indicated that the case company is developing new IIoT solutions with pilot customers in order to meet the customers' needs. However, the company cannot maintain such close communication with every customer. Thus, it has to create partnerships with customers who can tolerate some risk of piloting and who can communicate effectively.

A manufacturing companies are not the only ones creating value for a customer but rather for all collaborators (Westerlund et al. 2014; Chan 2015). One new form of partnership is closer relations in the value chain or the ecosystem. Distributors, logistics and service partners are a few examples of value chain actors. (Dijkman et al. 2015; Iivari et al. 2016) The empirical research revealed that the case company has identified the possibilities of the ecosystem and strives to create one. With ecosystem, the case company and ecosystem partners can offer more value for its customers. Moreover, every actor in the ecosystem should gain some added value so it would be a valuable addition to the ecosystem. Engström & Skoglund (2017) conclude that in order to create new and valuable partnerships, the company has to identify its place in an IIoT ecosystem

7.2 Business model development in the case company

The business model is a great way to see overall picture of the company's ways to make money. Business model framework helps to identify company's current business (Chesbrough 2007). With the business model, the company knows what resources and activities are needed in order to be able to provide the value proposition for the customers. Burmeister et al. (2016) argue that business model innovation is recognizing, capturing and reconfiguring skills needed to adapt to the changing business environment.

As we can see from the results of the empirical research the case company's business environment consists of so such many peculiarities that it is not possible to generate a general business model for every IIoT-driven companies and not even for every engager companies. However, the empirical research revealed several characteristics which can be seen in the IIoT-driven business models. To conclude the Business Model Canvas is an effective tool for designing the IIoT-driven business model as long as the company takes the peculiarities of IIoT-driven business into account.

With the Business Model Canvas, we were able to identify how the case company's IIoT business works. The case company's business is based on data activities. The company collects data from the customers and sells analyzed information back to the customers. The information is offered through applications and the customers get access to the information by buying the application. The case company's IIoT solution process is presented in Figure 18.

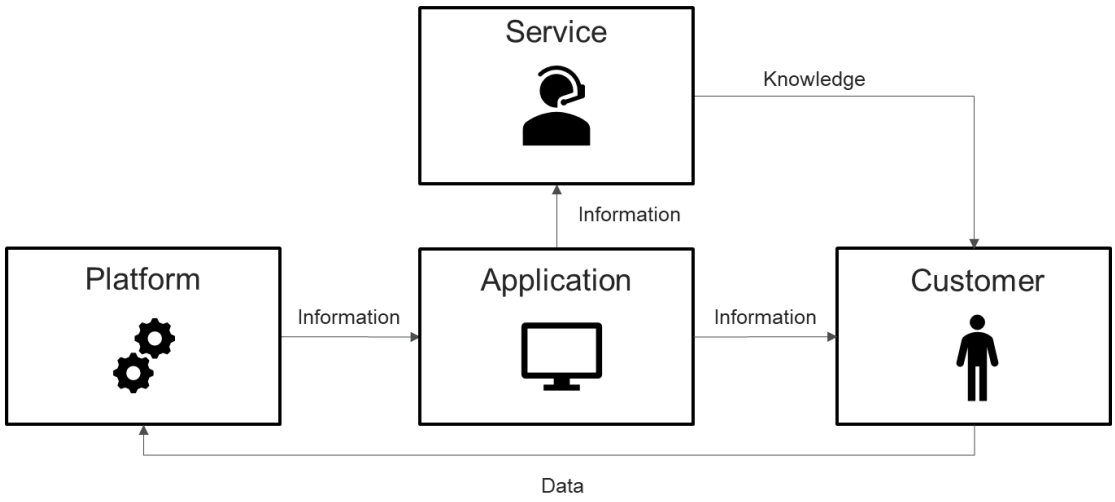

Figure 18 The case company's IIoT solution process.

With the analyzed information, the customers can operate its systems more efficiently and reliably. However, several issues were raised which have to be taken into account while designing IIoT-driven business model. Next, we discuss how business model patterns in the literature reflects the business in the case company. Then, we introduce issues which will have to be taken into account while designing IIoT-driven business model.

7.2.1 IIoT business model pattern

Results of the empirical research revealed that several business model patterns can be seen in the case company's business model. However, there is no single business model pattern in the literature which would thoroughly describe the case company's business model. From the Cevik's et al. (2018) six business model patterns Digital lock-in and Remote usage and condition monitoring describe the case company's business model best. In Digital lock-in business model the company tries to increase customer loyalty and ensure its customer base this way. Similarly, the case company tries to strengthen its market share within the current customer segments by offering IIoT solutions. In turn, Remote usage and condition monitoring describes the case company's offerings. According to Weinberger et al. (2016) in Remote usage and condition monitoring business model

the offerings can report about their condition or environment in real-time and allows errors to be detected in advance. The results of the empirical research state the case company's value propositions are based on data-based optimization, diagnosing the usage of the machine and advising the user to operate the machine

From Gassmann's et al. (2013) 55 business model patterns could be identified five patterns which describes the case company's business model. These business model patterns are Subscription, Performance-based contracting, Pay per use, Freemium and Solution provider. Subscription, Performance-based-contracting, Pay per use and Freemium are mainly revenue models and they do not describe other components of the Business Model Canvas. In Performance-based contracting the price is based on the performance the product delivers to the customer. (Gassmann et al. 2013) Thus, Performance-based contracting is actually business model with gain sharing revenue model.

The best description of the company's business model is Solution provider. Solution provider business model pattern compound products and services under a full coverage service. The company offers special know-how to increase customer's efficiency and performance. (Gassmann et al. 2013) However, even this business model pattern does not describe the case company's business model seamlessly. Based on the results of the empirical research the case company offers individual IIoT solutions which might cover both application and service, but the company does not offer full coverage service for whole system or factory.

7.2.2 Developing new IIoT-driven business model

Based on the empirical research we can derive list of issues which have to be taken into account while designing IIoT-driven business model with Business Model Canvas. First before starting business model development the designer must identify a promising position for the company (Ehret & Wirtz 2017). We have noticed that the company's role has big impact on company's business model. Thus, the designer must identify company's role in the IIoT business and its possible competitive advantages.

- *The case company offers IIoT products created by other companies for their customers and offer added value services for these products. According to Saarikko et al. (2017) engagers are usually non-IT companies which offer devices created by Enablers to create IIoT products/services for their customers. Thus, the case company operates as an Engager IIoT company.*

Second, we noticed that the case company's business model is customer-driven which guides the choice of other Business Model Canvas components. Moreover, we noticed that the company should identify its competitive advantage. Thus, we conclude that the the designer must next decide what are the epicenters of the business model innovation. The epicenter acts as a starting point for the business model innovation which has an impact on the other components. There can also be several epicenters. (Osterwalder & Pigneur 2010)

- *The company is creating IIoT solutions in order to fulfill its customer's needs and to strengthen its market share. The company has identified that it has also key resources which enables it to offer IIoT solutions but still the company lacks several needed key resources. Thus, the business model is rather customer-driven.*

According to Osterwalder & Pigneur (2010) customer-driven business model is based on customer's needs, facilitated access, or increased convenience.

Third, we noticed that the IIoT might create new customer segments and thus these must be considered. After identifying the company's position and the starting point of the business model innovation the designer must decide whether the company will expand its customer segments to multi-sided customer segments. Multi-sided business models differ from other business models.

- *The case company has decided to focus on their current customer segments.*

Fourth, we noticed that the designer must resolve how the company can ensure the data flow. It is essential that the company is aware of who owns the data and how the data can be used. Access to for the data can be ensured with an attractive value proposition. Moreover, the value proposition must be attractive enough so that the customer will pay a profitable price from the product.

- *Currently the company's IIoT solutions are monitoring solutions but next step is to create optimization solutions. The vision is however to create autonomous solutions. The company has not yet come up how they can ensure the data flow.*

Finally, we have noticed that the designer must take into account the components which affects the choice of the revenue models and the components which affects the choice of the distribution channel. Moreover, we noticed that role of key partners is high and key partners will probably change due to the IIoT.

8. CONCLUSION

The objective of this research was to reveal what kind of business model can support the IIoT software solutions business in a manufacturing company. Several companies are implementing IIoT solutions for their businesses but they don't know how to turn it to a profitable business. According to Littlefield (2016) one of the biggest challenge companies are facing while implementing the IIoT is how to build a business case. Although this research could not reveal fully generalized IIoT-driven business model, it helps the companies to determine and design suitable business model for them. In this chapter, the results of the research are summarized. Furthermore, the limitations of the research are introduced. Finally, the future directions are proposed.

8.1 Summary

The research question of this thesis was *what kind of business model can support the IIoT software solutions business in a manufacturing company*? To answer this question, we conducted literature review and empirical research with case study approach.

The literature review revealed that the topic is studied mostly in a general level and there are only few case studies concerning the subject. General characteristics and challenges of the IIoT-driven business models are studied but they do not take into account how these affects each other and what characteristics are appropriate for a certain company. Moreover, there is no distinction between industries and IoT roles of the companies in the literature.

The literature review revealed an enormous number of characteristics for the IIoT-driven business models. However, the literature review rather provided picture of all possible characteristics of the IIoT-driven business models than an applicable business model as such. Furthermore, the literature review revealed several challenges which the company has to take into account while implementing IIoT. Challenges are customers' resistance of change, high upfront investment, the complexity of the IIoT solutions and the difficulty of getting access to data. Finally, the literature review revealed that there are several business model patterns applicable for IIoT-driven companies

The characteristics of the IIoT-driven business models found in the empirical research supported the results of the literature research. All the characteristics found in the empirical research were presented in the literature as well. However, all the characteristics found in the literature review were not applicable for the case company. This supports the idea that business models presented in the literature are not applicable as such but rather provides a possibility for creating unique IIoT-driven business model for the company.

The empirical research revealed several challenges concerning the implementation of the IIoT-driven business model. The challenges supported the results of the literature review but we revealed new challenges as well. Found challenges are complex buying process, customers' resistance of change, understanding the customer's needs and value chain is difficult, risks included in gain sharing model, the difficulty of getting access to data, siloed business lines, high R&D costs and that proving the value proposition is hard.

Finally, the results of the empirical research indicated that some of the business model patterns found in literature review can be seen in the case company's business. However, none of these business model patterns describe the case company's business completely. Again, we conclude that the literature provides general business models which are not applicable as such.

Based on the literature review and empirical research we made seven findings which helps to determine what kind of business model can support the IIoT software solutions business in a manufacturing company. The findings are:

1. Customer segments affects the implementation of the IIoT.
2. Existing key resources might enable competitive advantage.
3. Cost structure, value propositions and customer segment affects the revenue streams.
4. Customer segments and value propositions affects to the distribution channel.
5. Value propositions must be attractive enough.
6. The company must ensure the connection to the customers' data.
7. Key partners are likely to change.

First finding indicates that the implementation of the IIoT has little or no at all effect to the customer segments but rather the customer segments guides the development of the IIoT-driven business model. However, this is the result of customers' strong position in this specific industry and does not necessarily apply in all situations.

Second finding denotes that engager companies needs the right resources in order to succeed. These resources might give the company a competitive advantage which helps them to compete with IT-companies. Third and fourth findings revealed new connections between Business Model Components in IIoT-driven business models. These components are tightly linked to together and one component cannot be designed without taking into account another.

Fifth finding considers the challenge of proving the value proposition found in the empirical research. The research indicated that there are enormous amount possible value propositions for the IIoT solutions and every company have to define right one for their purposes. However, the research revealed that the information security is an essential value proposition for every IIoT solutions. Moreover, the research indicated that the price alone is not the most important value proposition at least in this specific industry.

Sixth finding consider the difficulty of getting access to data which raised as a key challenge in both literature review and empirical research. The empirical research revealed that one way to ensure the access to data is providing value proposition attractive enough. Another way is to use the freemium model. However, the usage of freemium model is not studied enough. Finally, seventh finding indicate that the key partners are likely to change due to implementation of the IIoT. The IIoT drives company toward ecosystem based business.

To conclude we can say that there is no general IIoT-driven business model which would fit for every companies. The company must design its own unique IIoT-driven business by taking into account the industry, company's existing business model and peculiarities of the IIoT-driven business models. However, we were able to identify characteristics and challenges the company has to take into account while developing IIoT-driven business

model and how these characteristics and challenges affect each other. In addition, we revealed that Business Model Canvas is a valuable tool for developing IIoT-driven business models. Furthermore, we showed that business model patterns give a good high-level picture of the business model logic but they reflect poorly on individual company's business model.

8.2 Limitations

Yin's (2009) quality factors construct validity, reliability, external validity and internal validity were taken into account while conducting the research and the results of the empirical research were aligned with the literature. However, there were still few limitations in the research that should be taken into account when evaluating this research.

The construct validity was ensured by using multiple data sources. Data sources were documentations and interviews. However, there are limitation related to the construct validity. The interviewees were limited within the company. All the interviewees worked within the case company and customers or partners weren't interviewed. Thus, for example we rely on second hand knowledge about what and how the customers want to buy. However, the interviewees of the case company are professionals who have decades of experience. Thus, we can assume that the results of the empirical research are reliable. In addition, sample size of the research was 14 which is satisfactory in a case study.

The reliability of the study was ensured by documenting the progress of the research comprehensively. The interview template, questions, and durations and interviewees positions and country are all documented which increases the transparency of the research. In addition, the interviewees answers are linked to the interviewees position and the interview topic.

The criticism toward external validity is about generalizability of the results (Yin 2009 pp. 43-44.). This study is conducted in a specific industry context where customer segments are small but the purchasing power is high. Usually the external validity can be ensured by reflecting the study to the theory. However, this specific industry context has not been studied in the literature. Thus, in this research the external validity relies only on the more general components such as the business models' infrastructure components.

The criticism toward the internal validity of the case study state that researcher's conclusions of causal relationships are not valid. The broader criticism focuses on subjectivity of the researcher conclusions. In this case, the validity can be ensured by addressing rival explanations. (Yin 2009 pp. 42-43.) The internal validity is ensured by addressing different possible outcomes raised in the literature and empirical research and not just presented single solution for the research question.

Finally, there is limitation concerning the scope of the IIoT. The Three-Tier Topology architecture of the IIoT consist of edge, platform and enterprise tiers. However, this research is focusing only on platform and enterprise tiers and the edge tier is only studied superficially. The components of the edge tier have been studied in a general level but in the empirical part they have not been studied in more detail. This is partly because the edge tier is mainly developed on another department and the Industrial Internet department only use the interface of the edge tier.

8.3 Future directions

While studying business models of the Industrial Internet of Things we come up with several open questions that need to be addressed in further research. First, the research revealed that the customers' data include several issues. Issues were ownership, information security and value of data. Usually the customer owns the data which is generated by its system even though the company has developed and sold the system. The customer does not want to share its data because it is worried about its confidentiality. Thus, the future research should address how the company can ensure an access to the data and what is the value of data.

Secondly, we notice that the freemium model is one possible way to ensure an access to the customers' data. However, a deeper analysis is needed to understand how profitable the freemium model is as a data sources in B2B field. Moreover, the future research should address how the customers react to freemium model and if it has some negative effects to customer relationships.

Thirdly, the future research is needed to answer how the IIoT engager company's Business Model Canvas components affect each other. In this thesis, we concluded that in this specific case company the cost structure, value propositions and customer segment affects the revenue streams and the customer segments and value propositions affects to distribution channel. However, future research is needed to confirm if these connections are valid in every IIoT-driven B2B company or only in this specific industry.

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APPENDIX A: INTERVIEW TEMPLATE

Name of the interviewee(s):

Company / Institution:

Affiliation / Position:

Date:

Purpose of the interview:

Duration of the interview:

Questions	Current	Wanted
Who are our key partners? Who are our key suppliers? What resources we acquiring from partners? Which key activities partners does?		
What activities do our value proposition require? Our distribution channels? Customer relationships? Revenue streams?		
What resources do our value proposition require? Our distribution channels? Customer relationships? Revenue streams?		
What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? Which customer need are we satisfying? What bundles of products and services are we offering to each Customer Segment?		
What types of relationships do our customers expect us to establish and maintain with them? Which ones we have established? How costly they are?		
Through which channels do our customers want to be reached? How are we reaching them now? How are our Channels integrated?		
For whom are we creating value? Who are our most important customers?		
What are the most important costs inherent in our business model? Which resources or activities are most expensive?		
For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay?		

How much does each revenue stream contribute to overall revenue?		

Other notes: